Plexmotion

Robotic Gripper ARH350A

ARH Series

Operation Manual

RoHS compliant product

RoHS2

Thank you for purchasing our product.
This instruction manual contains important information for handling and use.Be sure to read and understand the manual for safe use before using.Always keep the manual accessible to read after reading.

REVISION 000 / Mar-2021

Table of contents

1. Precautions

1.1. Before use

This product described in here is designed and manufactured for the use in general industrial machineries including built-in applications such as "Suggested applications" described below. Note our product warranty policy is void when the product is used in “None suggested applications” described below.

● Suggested applications

General industry machineries including built-in applications such as automatic assembling machines, machining fixtures, inspection fixtures, factory automation machines.

● None suggested applications

Applications that may significantly affect human lives or properties, such as safety devices, transportation equipment including automobiles, automotive devices, aerospace planes and ships, medical devices, food manufacturing machines and home-use electric or electronic applications.

1.2. For safe use

Be sure to observe safety precautions described here.

⚠ Warning **Handling the product breaching this Warning notice may cause critical accidents such as serious injuries or even death.**

To prevent fires, electrical shock, injuries, malfunction of the product and/or damages to the product or your application, be sure to observe the followings.

- Do not use the product in explosive, flammable or corrosive environmental condition.
- Installation, connection, operation, control and inspection shall be completed by qualified personnel.
- Connect cables securely in accordance with this manual.
- Turn off the power supply once in the event of the power outage.
- Do not disassemble or modify the product. Contact a sales agent or our support center for internal inspection or repair.
- Keep the product away from flammable goods.
- Do not use the product under exposed to liquids such as water or oil, dust or metal powder.
- Do not wire or operate with wet hands.
- Do not apply excessive load or force to the product.
- Turn off the power supply before/while cable connection.
- Do not touch the product in energizing or just after disconnecting the power supply.
- Do not use the wrong or damaged product.

⚠ Caution **Handling the product breaching this 'Caution' notice may cause injuries or property damages.**

To prevent malfunction and/or damages to this product or your application, be sure to observe the followings.

- Keep sufficient wait time for reconnection after power OFF.
- Observe the input voltage range specified in this manual.
- Implement measures for antistatic electricity before handling the product.
- Use the product in accordance with the specifications.
- Observe the connection instruction specified in this manual.
- Do not plug or unplug the connecters while the product is energized.
- Do not handle the fingers or the connection cables for transportation.
- Do not drop or strike the product. The damaged product is not object to our warranty policy.
- Do not touch the product in operation.
- Equip an external emergency stop device or circuit.
- Stop the operation and turn off the power supply when a failure occurs.
- Do not use the product under exposed to direct sunlight.
- Do not use the product under exposed to continuous vibration or excessive impact.
- Protect the product from entry of foreign materials.
- Keep clearance between the inside of the hollow channel and the inserted material.
- Do not insert magnetic materials into the hollow channel.
- Dispose the product as industrial wastes.
- Perform risk assessment at user side.
- Do not wash and use alcohol, organic solvents such as thinner and benzine, and detergents containing abrasives. There is a risk of discoloration or deformation. When cleaning the robotic girpper, wipe it with a soft dry cloth to prevent scratches and damages.

Description of graphic symbol

⚠ **Be sure to read "Caution" or "Warning" note described beside this symbol.**

2. Product overview

2.1. Features and main functions

Features

This robotic gripper consists of a stepper and servo technologies to enable flexible gripping all sorts of different objects.
The gripper employs a special cam as a part of mechanism components. Accurate measuring and controlling of the motor current and rotation speed variation optimizes the grip force and grip speed even for soft or hard objects.

Main functions

Features	Description
Replaceable fingers	Replacing to proper fingers can work for various objects. Origin return operation measures the motion range between full-open and full-close and ensures appropriate open/close motion to finger size.
16 types of individual operation	Internal memory stores the various types of settings such as the target position, operation time and grip force of the finger. Up to 16 settings are available.
Operation by I/O signals	I/O signals can operate the gripper. The gripper equips 4 contacts for the I/O signals. Up to 4 contacts are assignable as the input signal, up to 2 contacts are assignable as output signal.
Operation via communication	Communication commands are available to operate the gripper. Open/close operation of the finger set by I/O signals is also available while monitoring the gripper status via communication.
Various protection functions	Protect functions such as over-voltage, low-voltage, over-heat and over-current prevent the gripper from failure.

3. Preparation and installation

3.1. Bundled items

Unpack and make sure the existence of all of following.

1. Robotic gripper ARH350A ····· 1pc
2. Connection cable 1 meter ····· 1pc
3. Standard finger, already mounted on the main body ····· 3pcs
4. Screw to fix the finger, already used to fix the fingers ····· 6pcs

3.2. Names and functions

Number in the figure above	Name	Description
①	Main body	This component is a main body of the robotic gripper, hereinafter called gripper.
②	Finger	These are the fingers.
③	Location to fix the finger	Use when replacing the fingers.
④	Hollow channel	A hole passes through the main body.
⑤	Main cable	Connect the main cable to the connection cable.
⑥	Tapped holes for mounting	Use the tapped holes to mount the gripper to the robot or the attachment.
⑦	Pilot lamp	The LED indicates operation or error status.
⑧ , ⑧ '	Option mounting screw hole	Use the hollow channel to equip other component.
-	Connection cable	The cable connects the gripper with the robot. Refer Section 4.1. for the detail of the connection cable.

3.3. Installing location

This product is designed and manufactured for the use in general industrial machineries includes built-in applications. Install the gripper in the environment below.

Items	Description
Place for use	Indoor
Ambient temperature in operation	0 degree C to + 40 degree C (+ 32 degree F to + 104 degree F)
Ambient humidity in operation	85% or less and no freezing or condensation
Atmosphere	No volatile gas, flammable gas or corrosive gas No exposure to liquid includes water or oil, dust and metal powder Not being subjected to continuous vibration or excessive impact Lower electromagnetic noise No exposure to direct sunlight

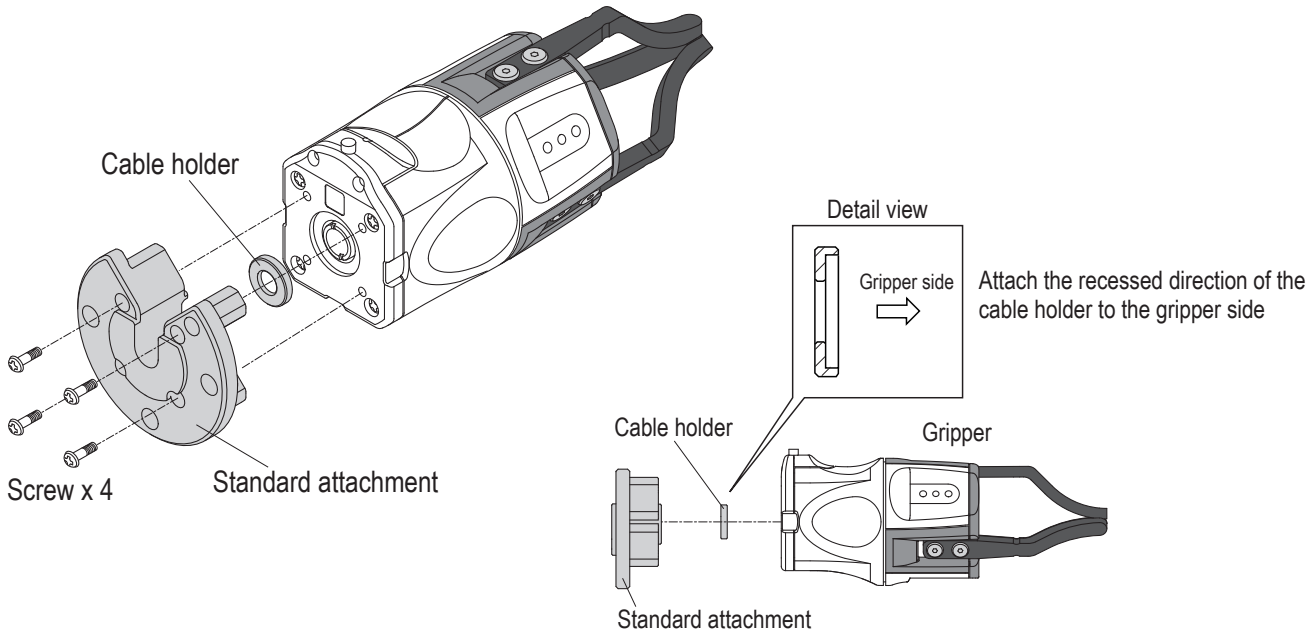
3.4. Installing to robot

Install the gripper to the robot before use.
This manual mentions the installation procedure to the robot manufactured by “UNIVERSAL ROBOT”.Contact your agent or our support center for the dedicated attachment or other company’s robot.

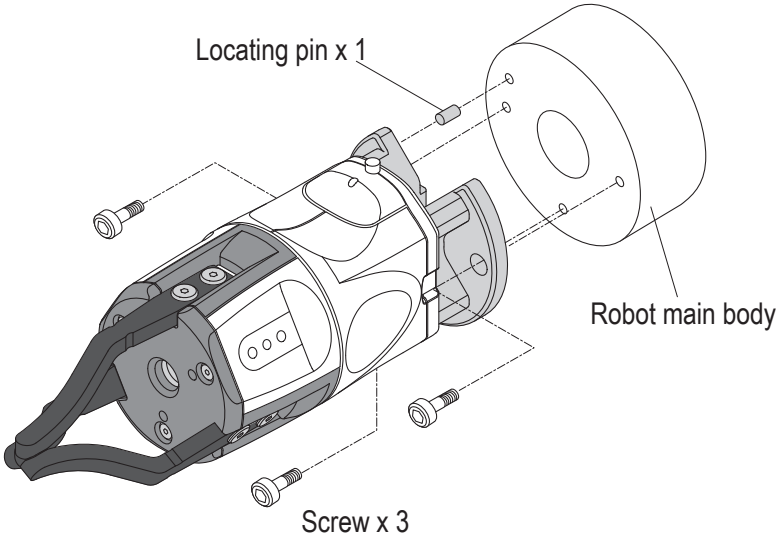
Standard Attachment (Sold separately) Included

Item Name	Description	Count
Screws	For attaching to gripper	4
Cable holder	For holding the cable	1
Positioning pin	For positioning	1
Screws	For mounting to robot flange	3
Hex Wrench (Short Neck)	Used when attaching to robot flange	1

1. Attach the dedicated attachment to the main body using screws supplied with the gripper. When passing the cables through the hollow channel, also pass the cables the hole of the cable holder.



2. Attach the dedicated attachment to the robot.



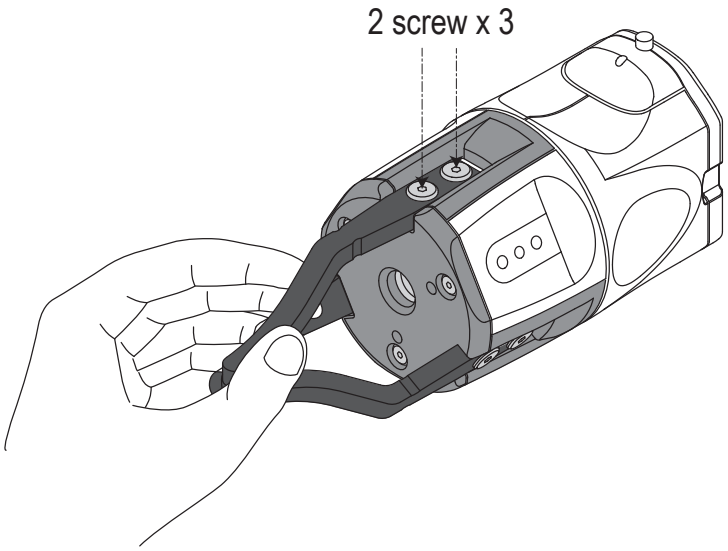
3. Connect the connection cable to the robot.

3.5. Finger replacement

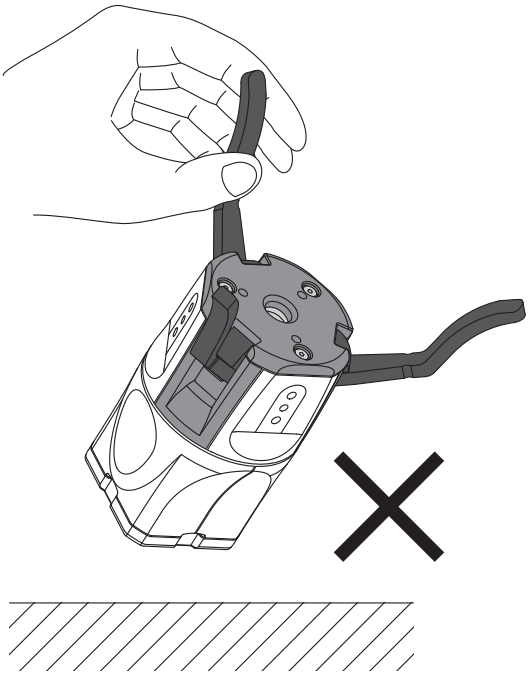
The fingers are replaceable to grip various objects.

1. Please prepare gripper with fingers slightly open from the fully closed position.
2. Prepare a 2.0 mm hex wrench.
3. Loosen two screws set in the finger with the wrench while keeping position of the finger then remove the finger.
4. Align two holes of new finger, then temporarily tighten the screws.
5. Tighten the two screws with the wrench while keeping position of the new finger. (1N•m max)
6. Repeat the 3rd to 5th process to replace other two fingers.

Refer to Section 6.2. to design original fingers.



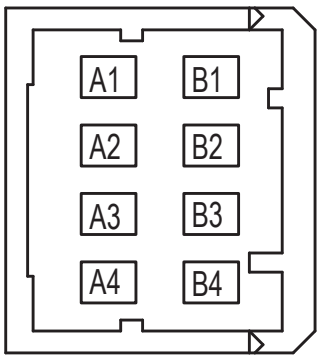
- Stop supplying the power to the gripper while replacing the fingers.
- Do not replace the fingers under unstable stand.
- Tightening the screw without keeping the finger position may damage the main body.
- Handling the gripper with only the finger may damage the main body.

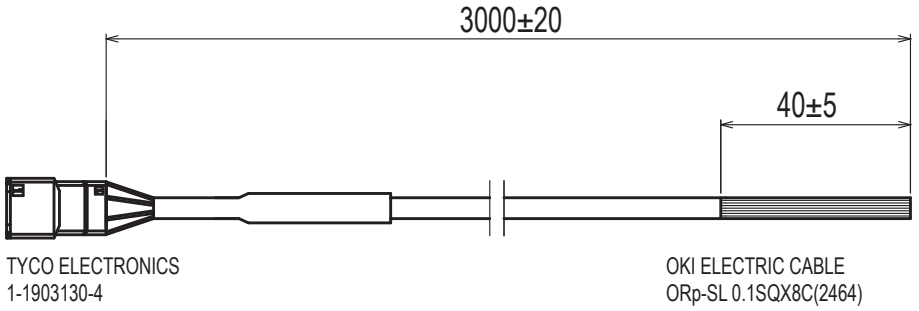


4. Input/Output signal interface

4.1. Connection cable

The connection cable has a connector with 8 pins.
Refer to left illustration for the pin-out of the connector.





Pin number	Wire color	Contact name	Signal name	Description
A1	Red	DC24V	Power +24V	For supplying power
B1	Black	GND	Power GND	For connecting to the power GND
A2	White	DI1	Input signal 1	Contact for the input signals
B2	Brown	DI2	Input signal 2	Contact for the input signals
A3	Gray	DIO3	Input/Output signal 3	Contact for the input/output signals
B3	Green	DIO4	Input/Output signal 4	Contact for the input/output signals
A4	Yellow	485A	RS485 Communication port (+)	Contact for communication with RS485
B4	Blue	485B	RS485 communication port (-)	Contact for communication with RS485

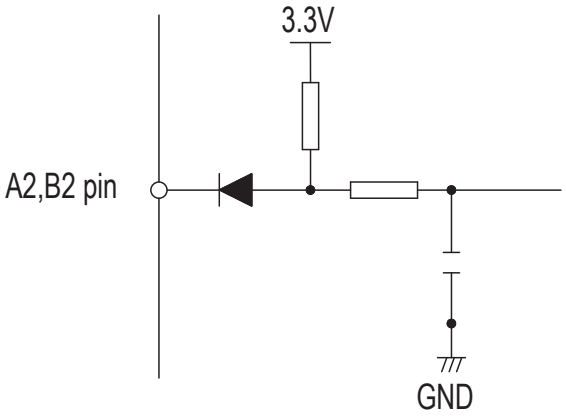
4.2. Input/Output signals

4.2.1. Signal specifications

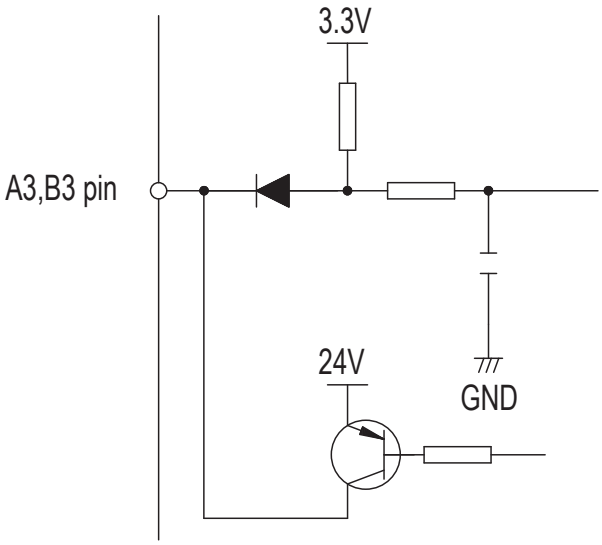
Items		Specifications
Interface	Input signal	Open collector type input interface H:OPEN L:0.8 Max [V] Open collector current: 4 Max [mA]
	Output signal	Digital PNP output interface H:26.4 Max [V] L:0.4 Max [V] *1 Source current: 12 Max [mA]

*1. Connect a resistor 47k [Ohms] for pull down.

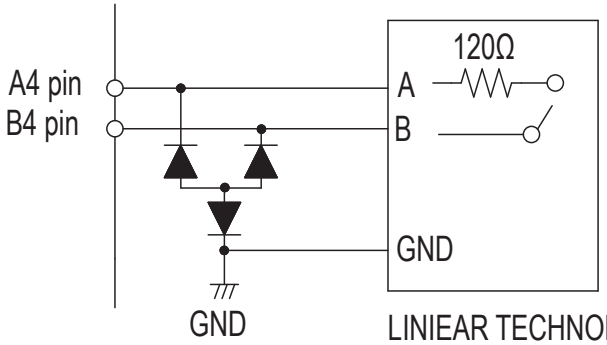
4.2.2. Circuit



Digital input



Digital input / output



Communication port

LINIEAR TECHNOLOGY LTC2854 or equivalent

4.3. Input contact

Functions shown in below table are assignable to the input signal 1 to 4.
Refer to Section 5.3. for details of the each input signal.

Signal name	Input logic	Input finalize time [msec Min]	Description
SRV_ON	Energizing: ON No energizing: OFF	10	Input ON starts energizing the gripper Input OFF stops energizing the gripper
HOME	Energizing: ON No energizing: OFF	10	Input ON starts the origin return operation
DRIVE	Energizing: ON No energizing: OFF	10	Once input is ON, the gripper reads the input status of SEL0 to SEL2, then starts open/close motion in accordance with the specified operation number
STOP	Energizing: ON No energizing: OFF	10	Once input is ON, the finer set stops the motion gradually then the gripper status changes to operation prohibited
ALM_RST	Energizing: ON No energizing: OFF	10	Input ON cancels the alarm status and Input OFF recovers
SEL0	Energizing: ON No energizing: OFF	10	Use 3 bits consist of SEL0, SEL1 and SEL2 to set the individual operation number SEL0 is the least significant bit and SEL2 is the most significant bit Individual number 0 to 7 are selectable. Only SEL Input signals can move the finger set when DRIVE Input signal is not assigned
SEL1	Energizing: ON No energizing: OFF	10	
SEL2	Energizing: ON No energizing: OFF	10	

4.4. Output contact

- Voltage level of the output signal is the same as the power supply.
- Wire inserting resistor(s) not to affect the host system.

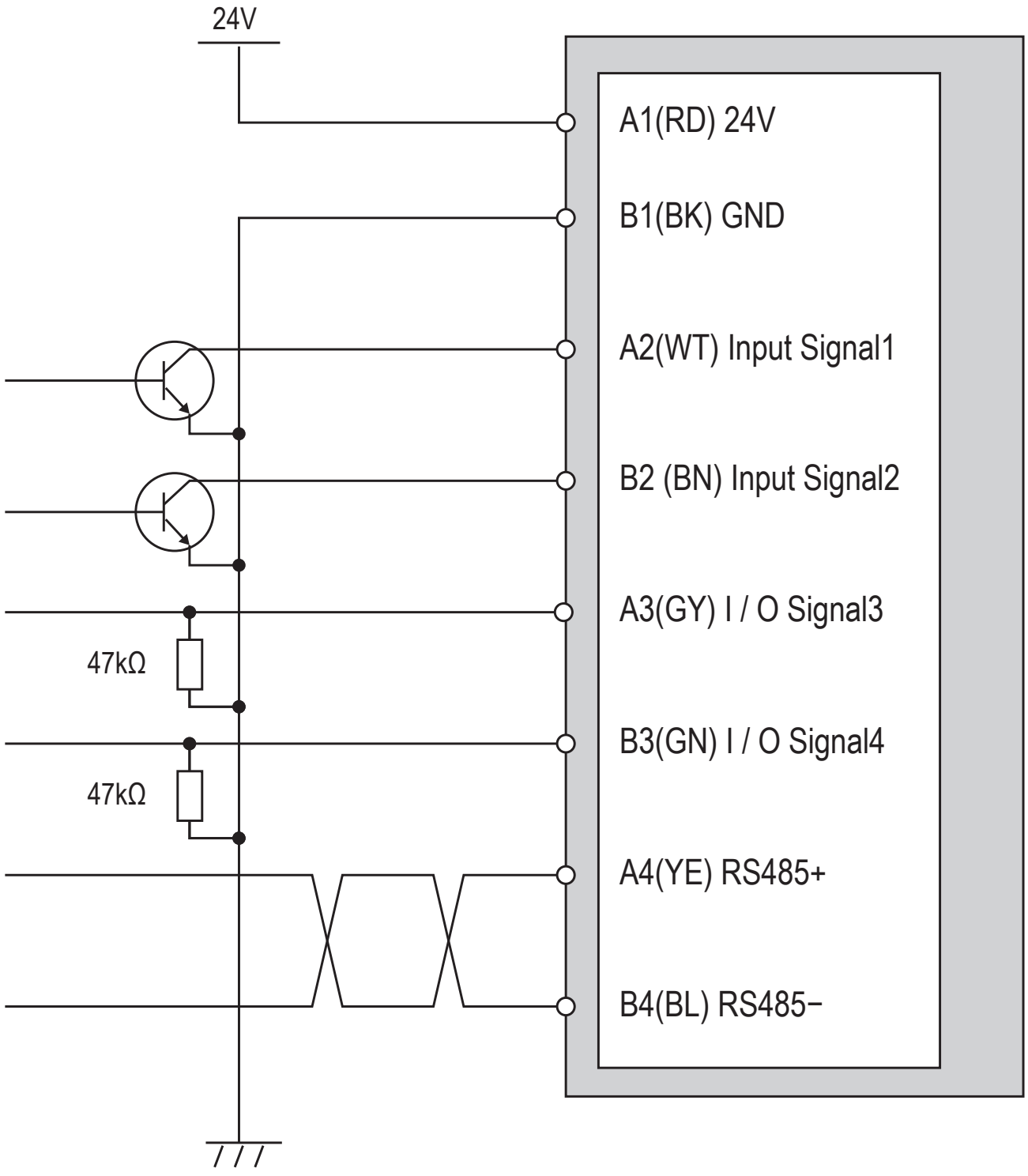
Functions shown in below table are assignable to the output signal 3 and 4.
Refer to Section 5.4.for details of the each output signal.

Signal name	Output logic	Output finalize time [msec Max]	Description
SRV	High ON Low OFF	5	The signal is ON while the gripper is energized The signal is OFF while the gripper is not energized
READY	High ON Low OFF	5	The signal is OFF in gripper operated, ON in waiting The signal is OFF while the gripper is not energized
ALARM	High ON Low OFF	5	The signal is ON in normal status Once any alarm is detected, the signal turns to OFF
GRIP_ERR	High ON Low OFF	5	The signal turns to ON once failure in gripping is detected
AREA	High ON Low OFF	5	When the position read from the encoder is within the specified area range, the signal is ON In case of being without the range, the signal is OFF

4.5. Connection examples

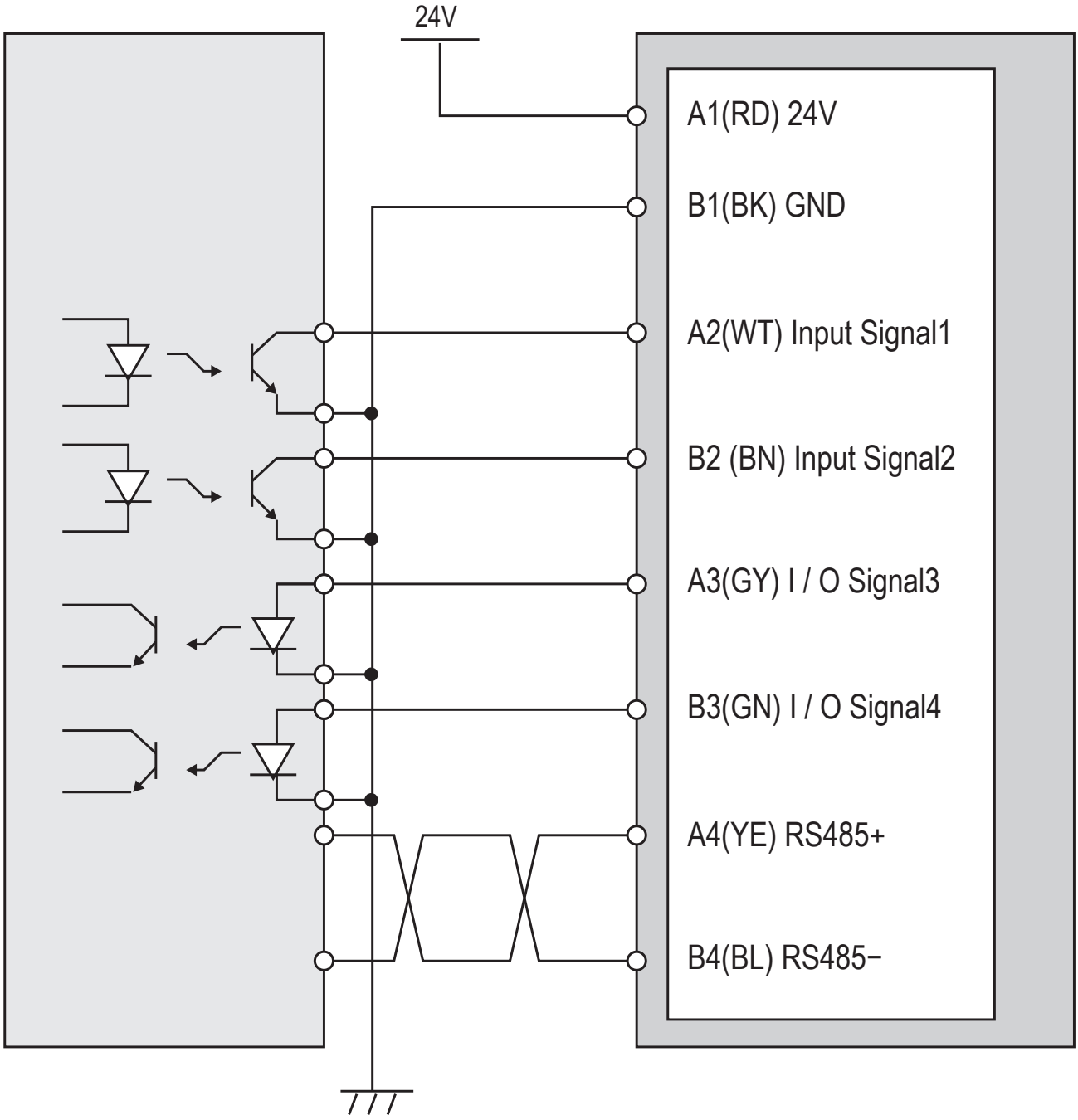
4.5.1. Open collector type

The example uses the input/output signal 3 and 4 for output.



4.5.2. Photo coupler type sink configuration

The example uses the input/output signal 3 and 4 for output.



4.6. Parameter settings

Update the parameters via communication to change the assignment of the signals.

Parameter name	Description
Input contact ID1	Select a function for the input signal 1
Input contact ID2	Select a function for the input signal 2
Input/Output contact ID3	Select a function for the input/output signal 3
Input/Output contact ID4	Select a function for the input/output signal 4

The default settings are shown in below table.
Send EEPROM initialization command via communication to reset the settings.

Parameter name	Default setting
Input contact ID1	SEL0 Input
Input contact ID2	ALM_RST Input
Output contact ID3	GRIP_ERR Output
Output contact ID4	ALARM Output

- The input contact 1 and 2 are used only for input signals.
- Select different functions in each contact.
- The settings for the input/output contacts are effective after rebooting the power supply.
- After change of the settings via communication, send EEPROM storage command via communication then reboot the power supply for setting update.

5. Operation procedure

This chapter describes the operation gripper.

- Secure 10 msec or more as the interval time between switching input signals.

5.1. Connection

Connect the gripper to the host system using the connection cable.
Connect the power lines of the robot by A1 and B1 pins in the connection cable.

- Be sure for connection being careful to the polar of the power supply.
- Improper connection in polarity of the power supply may damage the gripper.

5.2. Power ON

Set the voltage level of the power as necessary supply within DC+24 V +/-10 %.
Note that the gripper starts to move just after power ON when origin return operation on start-up is valid.

- Reboot the power after the LED indicators are completely OFF.

5.3. Input signals

This section describes the procedure of the input signals.

The input signals are available to start the origin return operation and to execute the open/close motion.
SRV_ON Input signal is available to switch between energizing / non energizing the gripper, and STOP Input signal is available to select operation prohibited status.

Open/close motion starts once DRIVE Input signal turns to ON. When the DRIVE Input signal is invalid, the motion starts once any of SEL0 to SEL2 changes its status.

Priority level of the input is [SRV_ON > STOP > HOME, DRIVE, SEL*].
The gripper stays on no energizing status and does not start operation when SRV_ON Input is OFF even though DRIVE Input signal turns to ON.

Origin return operation

SRV_ON	STOP	HOME	Command to the gripper
OFF	ON	OFF	Free
OFF	ON	ON	
OFF	OFF	OFF	
OFF	OFF	ON	
ON	ON	OFF	Hold with operation prohibited
ON	ON	ON	
ON	OFF	OFF	Hold with operation permitted
ON	OFF	ON	Origin return operation

SRV_ON	STOP	HOME	Command to the gripper
	ON	OFF	Hold with operation prohibited
	ON	ON	
	OFF	OFF	Hold with operation permitted
	OFF	ON	Origin return operation

SRV_ON	STOP	HOME	Command to the gripper
OFF		OFF	Free
OFF		ON	
ON		OFF	Hold with operation permitted
ON		ON	Origin return operation

SRV_ON	STOP	HOME	Command to the gripper
		OFF	Hold with operation permitted
		ON	Origin return operation

Operation by DRIVE signal

SRV_ON	STOP	DRIVE	SEL ∗	Command to the gripper
OFF	ON	OFF	X	Free
OFF	ON	ON	X	
OFF	OFF	OFF	X	
OFF	OFF	ON	X	
ON	ON	OFF	X	Hold with operation prohibited
ON	ON	ON	X	
ON	OFF	OFF	X	Hold with operation permitted
ON	OFF	ON	X	Operation by SEL operation number X

X : Any SEL ∗ input number

SRV_ON	STOP	DRIVE	SEL ∗	Command to the gripper
	ON	OFF	X	Hold with operation prohibited
	ON	ON	X	
	OFF	OFF	X	Hold with operation permitted
	OFF	ON	X	Operation by SEL operation number X

X : Any SEL ∗ input number

SRV_ON	STOP	DRIVE	SEL ∗	Command to the gripper
OFF		OFF	X	Free
OFF		ON	X	
ON		OFF	X	Hold with operation permitted
ON		ON	X	Operation by SEL operation number X

X : Any SEL ∗ input number

SRV_ON	STOP	DRIVE	SEL ∗	Command to the gripper
		OFF	X	Hold with operation permitted
		ON	X	Operation by SEL operation number X

X : Any SEL ∗ input number

Operation by SEL signal input

SRV_ON	STOP	DRIVE	SEL ∗	Command to the gripper
OFF	ON		X	Free
OFF	ON		X → Y	
OFF	OFF		X	
OFF	OFF		X → Y	
ON	ON		X	Hold with operation prohibited
ON	ON		X → Y	
ON	OFF		X	Hold with operation permitted
ON	OFF		X → Y	Operation by SEL operation number Y

X : Any SEL ∗ input number, Y : The number updated by SEL operation

SRV_ON	STOP	DRIVE	SEL ∗	Command to the gripper
	ON		X	Hold with operation prohibited
	ON		X → Y	
	OFF		X	Hold with operation permitted
	OFF		X → Y	Operation by SEL operation number Y

X : Any SEL ∗ input number, Y : The number updated by SEL operation

SRV_ON	STOP	DRIVE	SEL ∗	Command to the gripper
OFF			X	Free
OFF			X → Y	
ON			X	Hold with operation permitted
ON			X → Y	Operation by SEL operation number Y

X : Any SEL ∗ input number, Y : The number updated by SEL operation

SRV_ON	STOP	DRIVE	SEL ∗	Command to the gripper
			X	Hold with operation permitted
			X → Y	Operation by SEL operation number Y

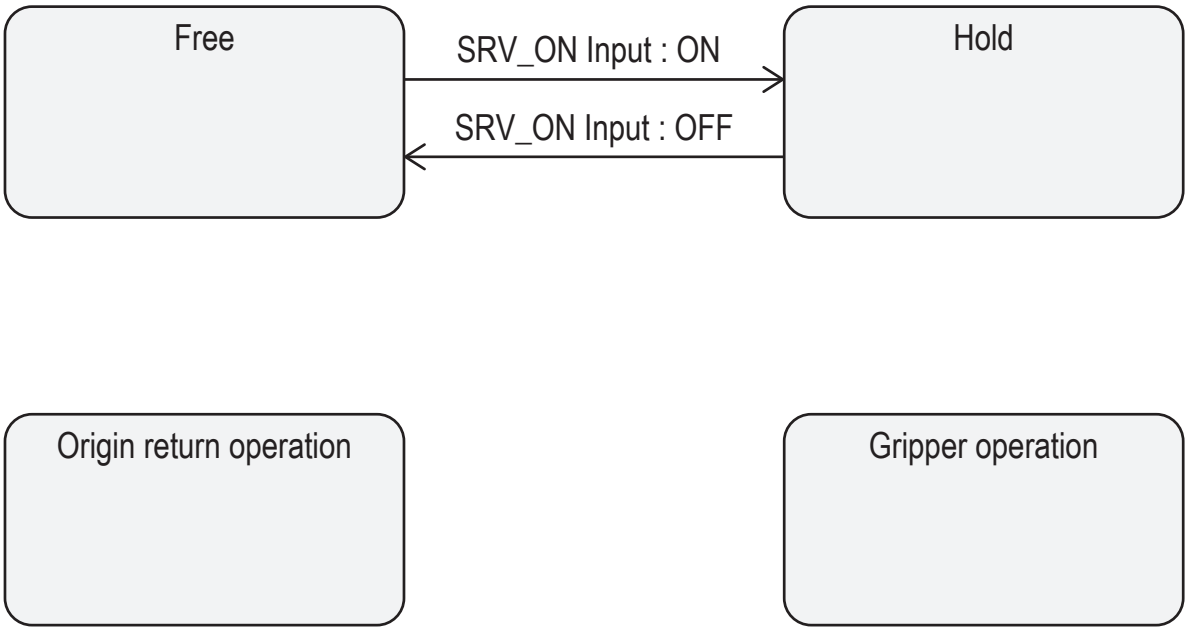
X : Any SEL ∗ input number, Y : The number updated by SEL operation

5.3.1. SRV_ON Input

Use SRV_ON Input to switch between energizing/no energizing the gripper.

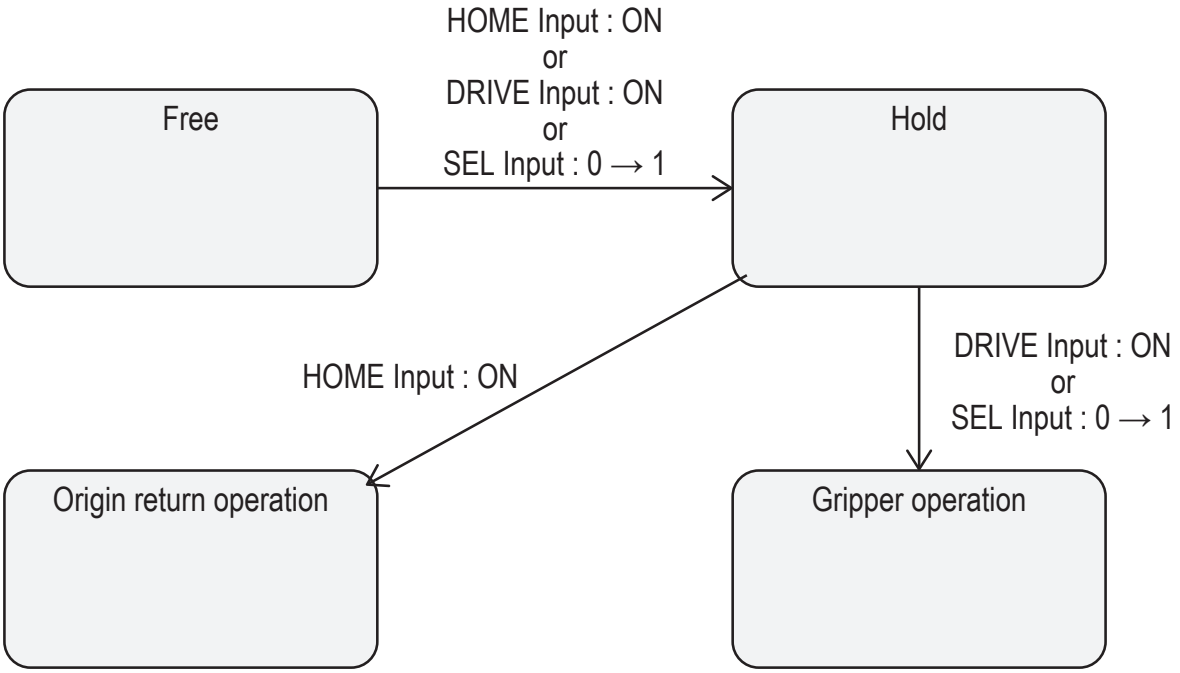
5.3.1.1. SRV_ON Input is valid

Turn ON SRV_ON signal to start energizing the gripper then keep in hold status.
Turn OFF the signal to stop energizing the gripper. While no energizing status, grip force is 0 (zero).



5.3.1.2. SRV_ON is invalid

Energizing the gripper is not stopped when SRV_ON Input signal is invalid.
Use other operation command or input signal to restart energizing the gripper.



5.3.2. HOME Input

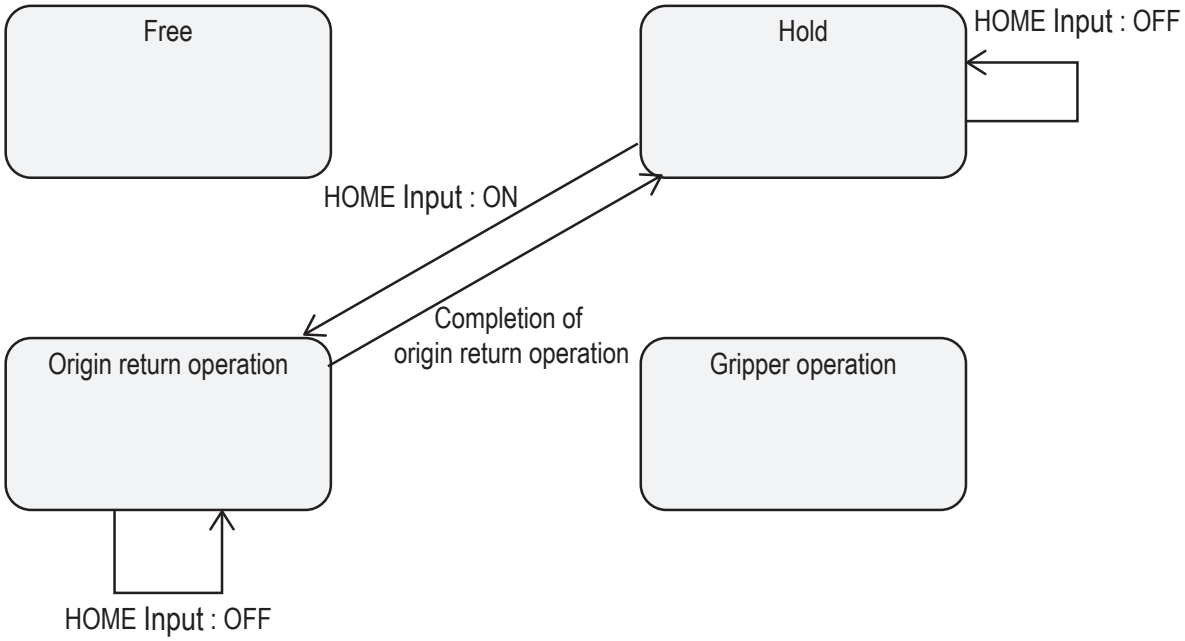
Use HOME Input to order the origin return operation.

The origin position is set by the internal mechanism of the fully open position of the hand, the fully closed position, and the abutting of the finger. The origin position can be changed by establishing abutting of the finger at any position in the opening / closing direction.

5.3.2.1. HOME Input is valid

Turn on HOME Input signal to starts the origin return operation. The operation is not canceled even though turning OFF the signal. Turn on the signal to restart the origin return operation after completion of the previous operation.

- Remove objects from the finger set before the origin return operation to prevent damage by gripper motion while the operation.



5.3.2.2. HOME Input is invalid

Origin return operation by the input signal is not valid.
To execute the origin return operation, activate the setting for the return origin operation at a time of start-up or execute the operation via communication command.

5.3.3. DRIVE Input and SEL Input

Use SEL Input signal to select the individual operation number 0 to 7.

Operation number	SEL2	SEL1	SEL0
0	OFF	OFF	OFF
1	OFF	OFF	ON
2	OFF	ON	OFF
3	OFF	ON	ON
4	ON	OFF	OFF
5	ON	OFF	ON
6	ON	ON	OFF
7	ON	ON	ON

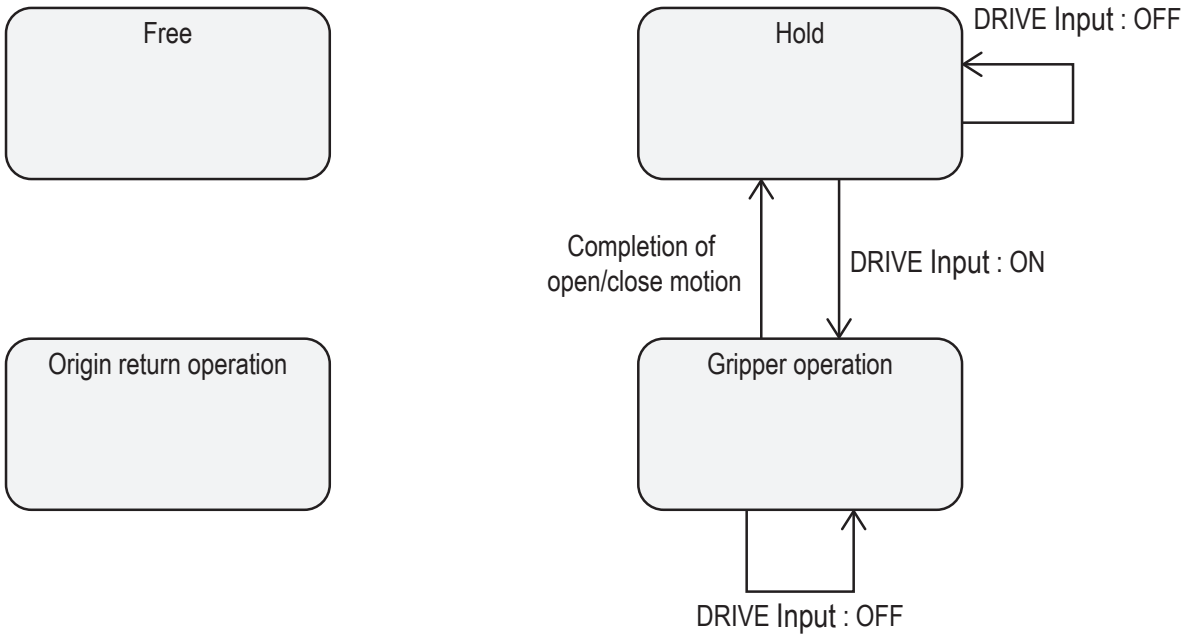
Not assigned SEL is treated as OFF.
When only SEL2 is valid, the operation number 0 is selectable by turning the signal to OFF and the operation number 4 is selectable by turning to ON.

The operation number 8 to 15 are not selectable by SEL Input signal. Use communication command.

5.3.3.1. DRIVE Input is valid

At the time of DRIVE Input signal turns to ON, the fingers start motion in accordance with the operation number selected by SEL Input.
The fingers do not stop the motion even though DRIVE Input signal is turned to OFF in motion.
When DRIVE Input turns to ON in motion, the fingers stop the motion then starts next motion in accordance with new operation number. This action is applicable to the case that the new operation number is the same as the previous one.

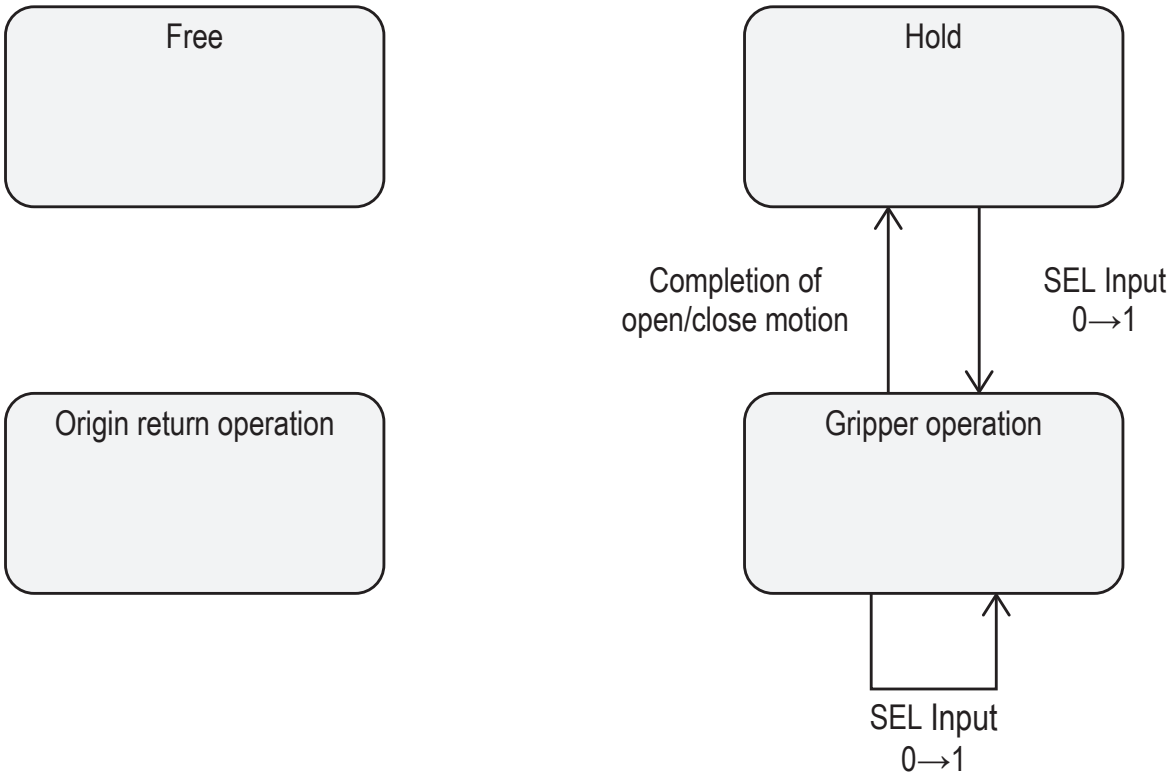
- Do not input DRIVE Input and SEL Input at the same time.
- Set SEL Input signals preliminarily. Otherwise unspecified operation number may be selected.



5.3.3.2. DRIVE Input is invalid

Use SEL Input signals to start the gripper.
Once the controller detects the status change, ON to OFF or OFF to ON, in any of SEL0 to SEL2, the fingers start the motion in accordance with the operation number selected by SEL Input.

When any status change is detected in motion, the fingers stop gradually the motion then restarts next motion in accordance with new operation number.



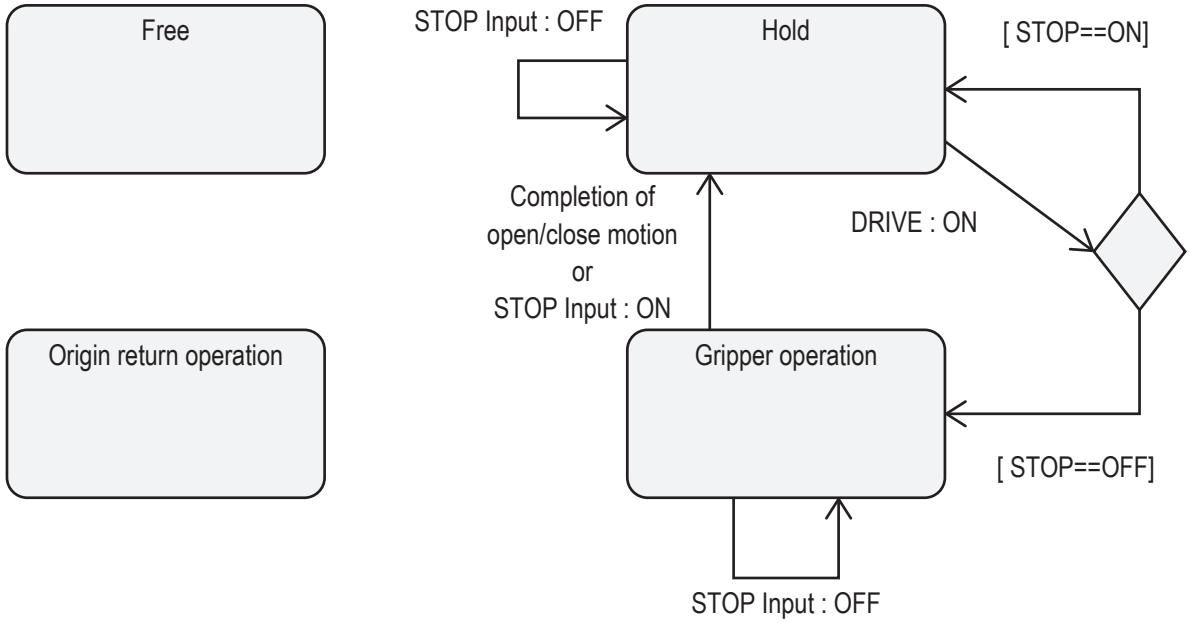
5.3.4. STOP Input

Use STOP Input signal to prohibit gripper operation.

5.3.4.1. STOP Input is valid

Once STOP Input signal turns to ON, the fingers stop the motion gradually. The fingers continues the current motion even STOP Input signal is OFF in motion.

- Request to start operation by the signals, HOME Input, DRIVE Input or SEL Input, are unacceptable while STOP Input is ON.



5.3.4.2. STOP Input is invalid

The gripper starts operation in accordance with the settings of DRIVE Input or SEL Input signal.

5.3.5. ALM_RST Input

Use ALM_RST Input to cancel the alarm status.

5.3.5.1. ALM_RST Input is valid

Change the signal status to OFF from ON to cancel the alarm status.
Turn ALM_RST Input to ON after 1 msec or more from the determination of the alarm, and keep the ON status for 10 msec or more.
The alarm is canceled after 10 msec or more from ALM_RST Input turns to OFF.

5.3.5.2. ALM_RST Input is invalid

Conditions to cancel the alarm are different in case of gripper is energized or not.

- In the no energized, the alarm is canceled at the timing of start energization input.
- In the energized, even in abnormal stop, the alarm is canceled at the timing of operation signal input.

The example to recover from the no energized status caused by the alarm with SRV_ON Input signal.
When SRV_ON Input signal is valid, keep the signal OFF for 10 msec or more then switch to ON. After 10msec from the switching, the gripper cancels the alarm then starts energizing.

5.4. Output signals

Use ALM_RST Input to cancel the alarm status.

5.4.1. SRV Output

The output is ON while energizing, the output is OFF while no-energizing.
At the first energizing, the output keeps being OFF until completion of the initializing operation.

5.4.2. READY Output

The output is OFF in operating and ON in ready and waiting.
The output is also ON while the finger set is gripping the object after positioning operation.

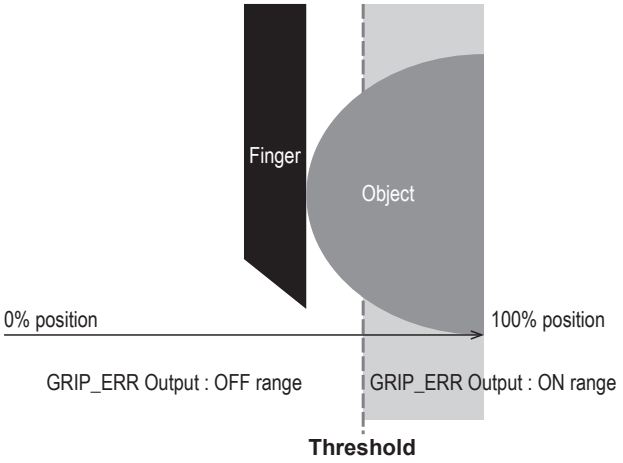
The output is OFF in no energizing the gripper.

5.4.3. ALARM Output

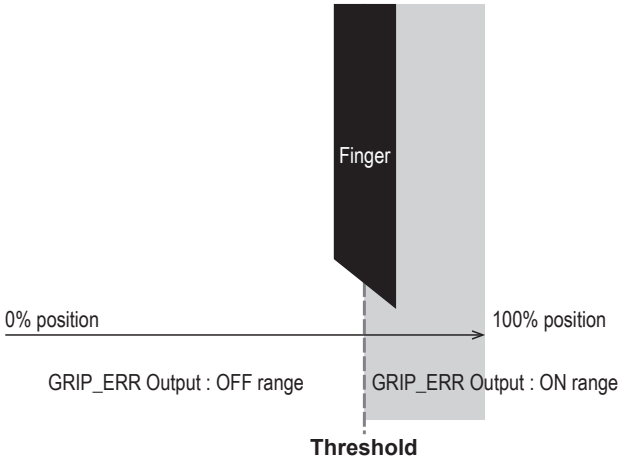
The output is ON in normal status and the output turns to OFF once into abnormal status.
The output turns to ON from OFF once the alarm reset operation completed.
The output is OFF while initializing configuration just after start-up power supply.

5.4.4. GRIP_ERR Output

GRIP_ERR Output is a signal to transfer gripping failure status to the host.
The output is OFF while gripping the object. The output turns to ON after the finger arrived at the target position with no gripping object.



Example of GRIP_ERR Output : OFF



Example of GRIP_ERR Output : ON

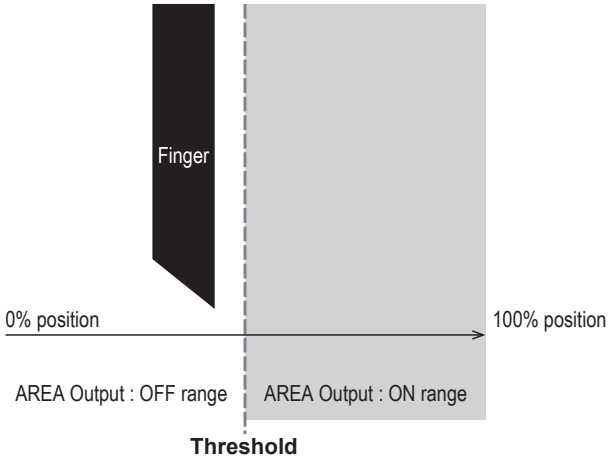
The output is OFF when the gripper is in no energized by SRV_ON Input signal or the finger set is gradually stopped by STOP Input signal.

Controller status	GRIP_ERR Output
In initializing configuration	OFF
Before origin return operation	OFF
In/after origin return operation	OFF
Free, out of GRIP_ERR range	OFF
Free, in GRIP_ERR range	OFF
Hold out of GRIP_ERR range	OFF
Hold, in GRIP_ERR range	ON
In operating, out of GRIP_ERR range	OFF
In operating, in GRIP_ERR range	ON

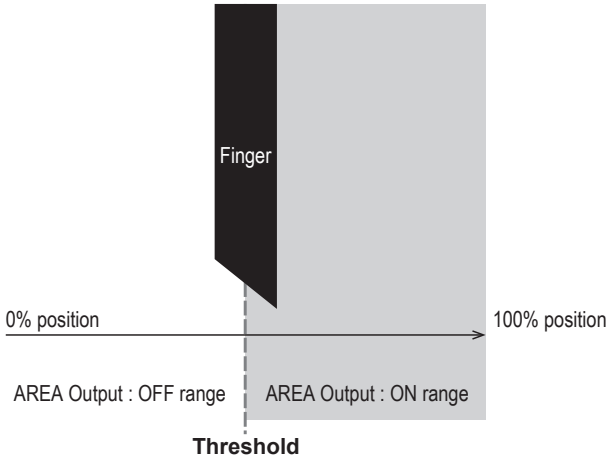
Set the parameters to adjust the GRIP_ERR range.

5.4.5. AREA Output

AREA Output is a signal to transfer the host the status that the finger position is within the specified area or not.
In the specified area, the output is ON. Out of the specific area, the output is OFF.



Example of AREA Output : OFF



Example of AREA Output : ON

The range of AREA Output is valid, even though the griper is no energized by OFF of SRV_ON Input or the fingers are stopped gradually by STOP Input. The finger is in the specific area, the output is ON. Out of the specific area, the output is OFF.

Controller status	AREA Output
In initializing configuration	OFF
Before origin return operation	OFF
In/after origin return operation	OFF
Free, out of AREA range	OFF
Free, in AREA range	ON
Hold out of AREA range	OFF
Hold, in AREA range	ON
In operating, out of AREA range	OFF
In operating, in AREA range	ON

Set the parameters to adjust the AREA range.

5.5. Communication commands

Use communication command to operate the gripper and configure settings after connecting the power cables and the communication cables.

- Wire cables and configure settings not to conflict with the input signals in case for open/close motion via the communication command.

5.5.1. Procedure of communication

This section describes the procedure of the communication.
Refer to Chapter 7 for specifications of the operation commands.

1. Send the operation command “Energize” to get the fingers to hold when the gripper is no energized,
2. When the origin return operation on start-up is invalid, send the operation command “Origin return operation” to confirm whether the operation completed or not through sending/receiving the status referral.
3. Send the operation command “Operation number 1”to move the fingers toward closing.
4. Send the operation command “Operation number 0”to move the fingers toward opening.
5. Send the operation command “Deceleration stop” to stop the ongoing motion.
6. Send the operation command “No energize” to stop energizing the gripper. Send the operation command “Energize” to get the gripper be energized again.

* The operation number described in the subsection 3 and 4 above is settable to any one from 0 to 15.

5.6. Parameter settings

Only the communication can set the parameters. The set results are stored in the main body by sending the command of EEPROM storage.
The parameter is set per each operation number, 16 types of parameters are settable.

5.6.1. Target position

Set the target position at between 0% as full open and 100% as full close.
Set the parameter in unit of permillage 0.1%.

In the default settings, the operation number 0 is set to 0% and 1 is set to 100%. The fingers open or close by only selecting the operation number 0 or 1.

Operation number	Target position
0, 2	0%
1, 3 to 15	100%

- The resolution capacity is more than 0.1% when the finger motion range is less than 7 degrees.
- The gripper performs the origin return operation every time after start-up. Therefore the target position of the finger is affected by aging degradation.
- Set the parameter having safety margin against the object size.

5.6.2. Operation time

The operation time is the time to move the finger in the full stroke distance between from the full open 0% position to the full close 100% position.The actual operation time is shorter than the set operation time when the actual stroke distance is shorter than the full stroke distance.
Set the parameter in unit of msec.

The controller figures out the operation speed, the acceleration time and the deceleration speed considering the set operation time and the full stroke distance, then moves the fingers.

5.6.3. Grip force

Adjust the parameter of the upper limit torque to restrict the grip torque in open/close motion.
The higher value makes the grip force stronger and the lower value makes the grip force weaker.
The parameter is recognized with truncation in unit of 0.5%.

The default settings of the upper limit torque are shown in below table.

Operation number	Upper limit torque
0 to 15	80%

5.6.4. Output signal range

Set the output range of GRIP_ERR signal and AREA signal to somewhere between 0% position to 100% position.
The upper limit and the lower limit are available.
No signal output when the upper and the lower limits are the same value.

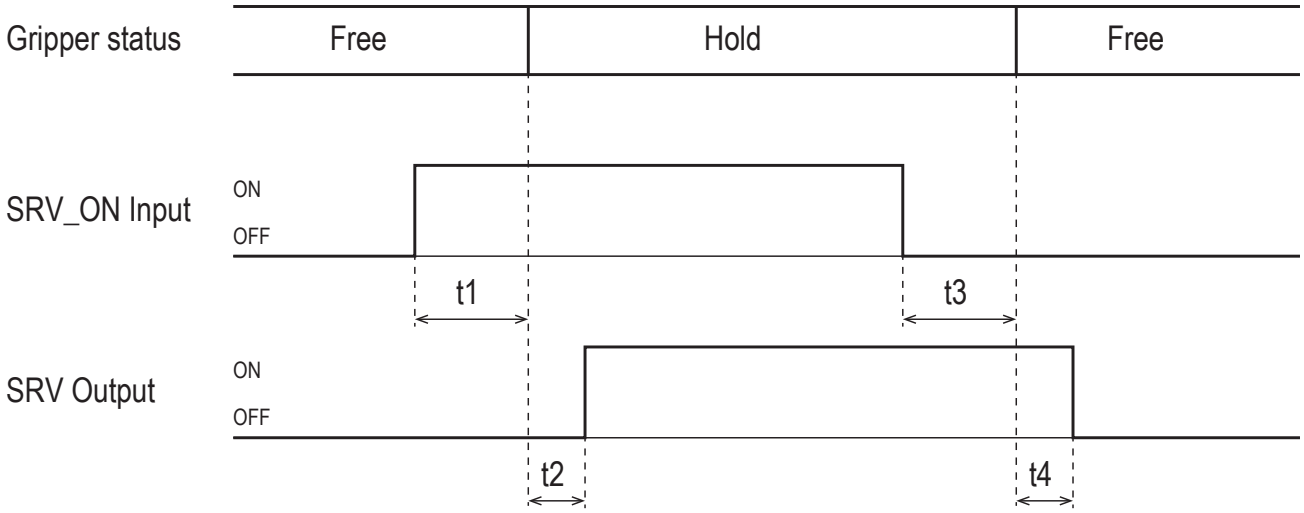
The output range of GRIP_ERR signal can be set to each operation number. The setting is effective at starting operation.
The setting that the output of GRIP_ERR is invalid can be set to the operation number 0 that the open operation is already assigned.

The output range of AREA signal is also settable to each operation number. The setting is effective at starting operation.

- Small object may cause output of the GRIP_ERR signal even the gripping completed.
- Adjust the output range of the signals in accordance with the object size.
- The output range of AREA Output signal is different from each operation number.
- In case to uniform specifications of AREA Output in open/close motion, set the same parameters of the output range to each operation number.
- The output torque may vary depending on the environment temperature. Do not apply more than 100% torque set value to continuous operation.

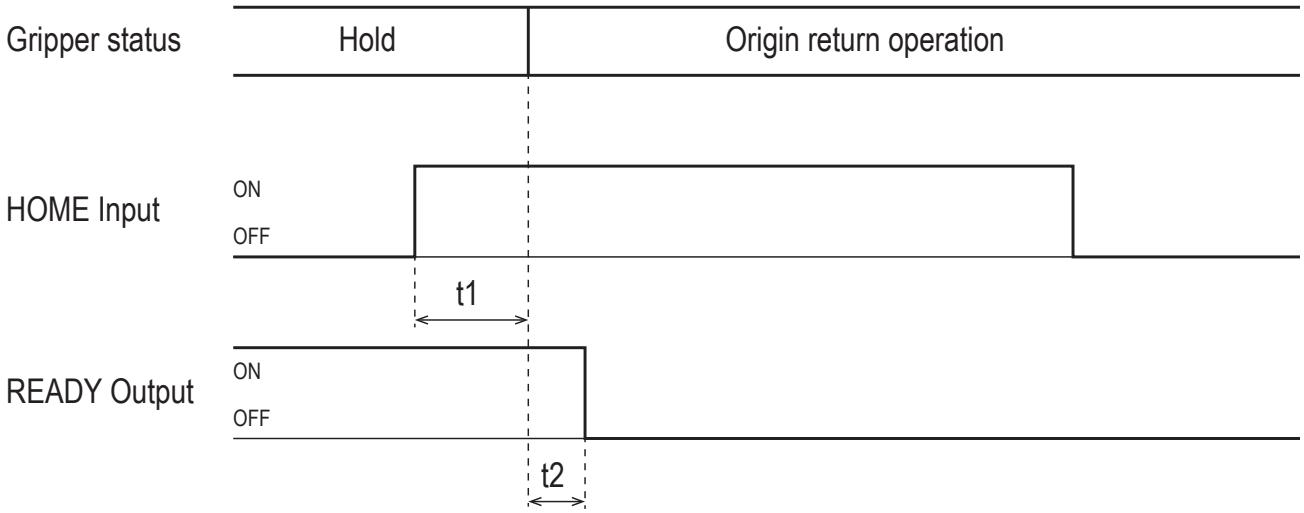
5.7. Timing chart

5.7.1. SRV_ON Input



Symbols	Description	Units	Min	Typ	Max
t1	Finalize time after SRV_ON Input signal is ON	msec	10	—	—
t2	Delay time after SRV Output signal is ON	msec	—	—	5
t3	Finalize time after SRV_ON Input signal is OFF	msec	10	—	—
t4	Delay time after SRV Output signal is OFF	msec	—	—	5

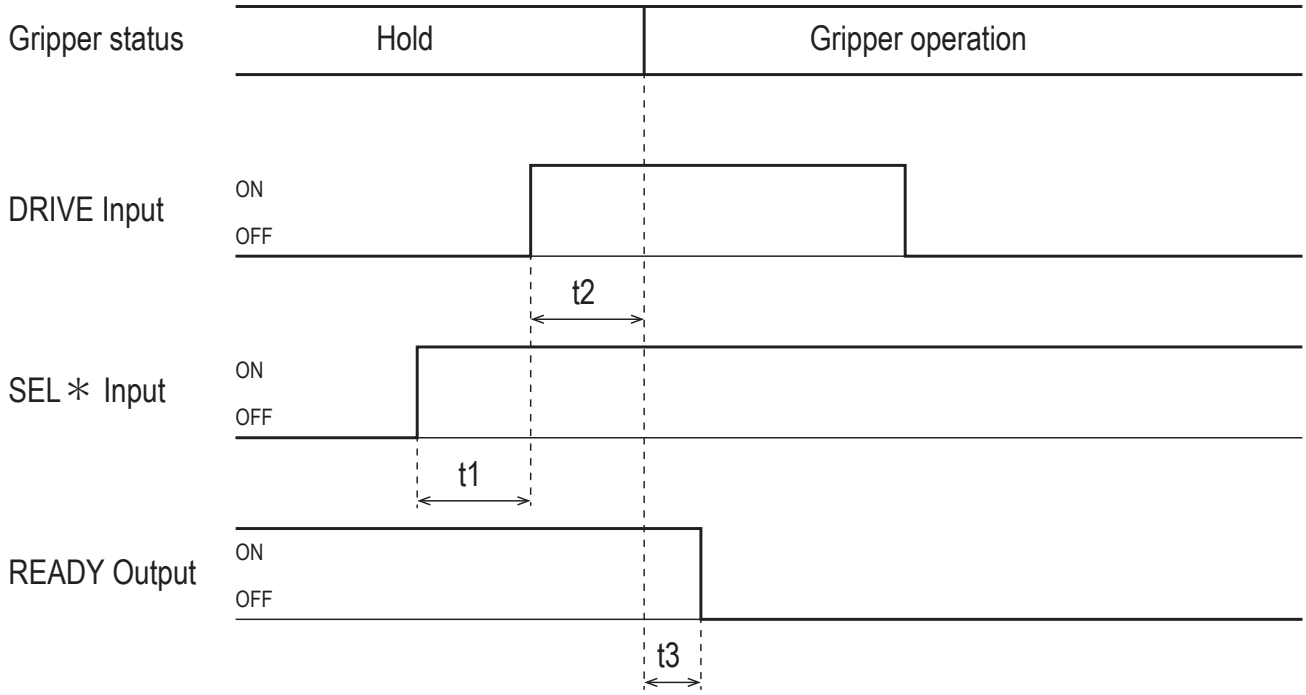
5.7.2. HOME Input



Symbols	Description	Units	Min	Typ	Max
t1	Finalize time after HOME Input signal is ON	msec	10	—	—
t2	Delay time after READY Output signal is OFF	msec	—	—	5

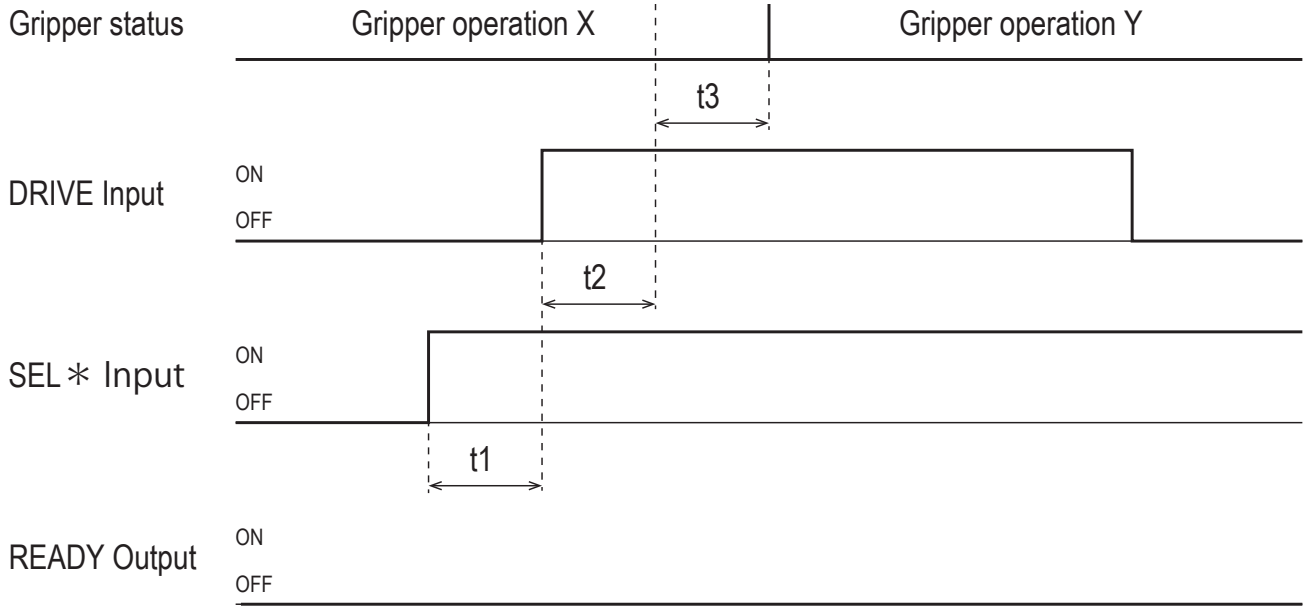
5.7.3. DRIVE Input

5.7.3.1. Gripper start up



Symbols	Description	Units	Min	Typ	Max
t1	Finalize time after SEL ∗ Input signal is ON	msec	10	—	—
t2	Finalize time after DRIVE Input signal is ON	msec	10	—	—
t3	Delay time after READY Output signal is OFF	msec	—	—	5

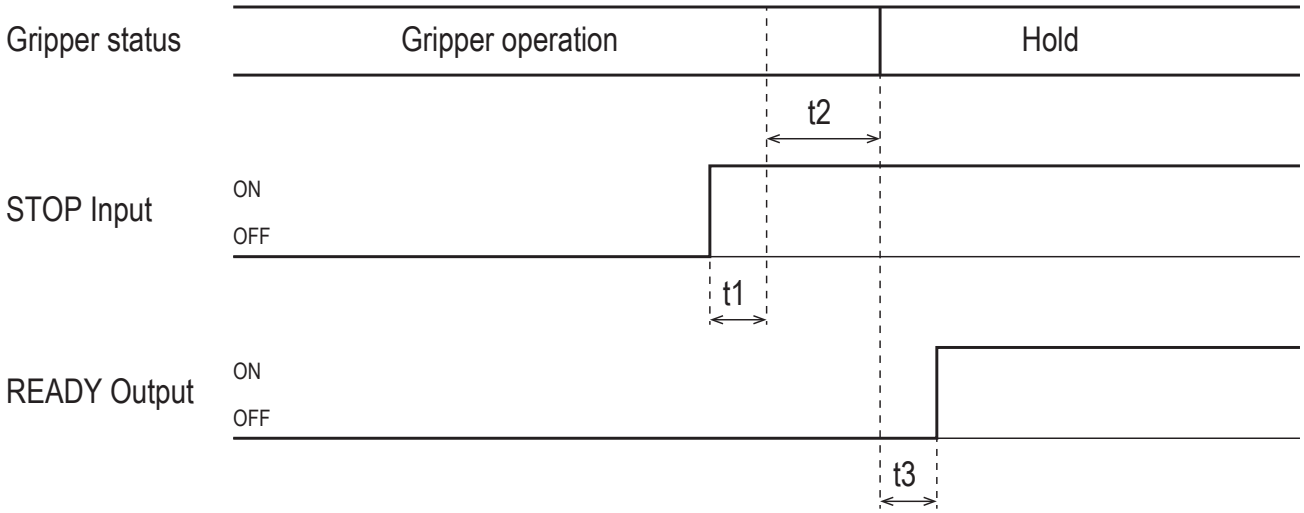
5.7.3.2. Switch operation in operating



Gripper operation X, Y : X = 0 to 7, Y ≠ X

Symbols	Description	Units	Min	Typ	Max
t1	Finalize time after SEL ∗ Input signal is ON	msec	10	—	—
t2	Finalize time after DRIVE Input signal is ON	msec	10	—	—
t3	Decelerating time to stop	msec	—	100	—

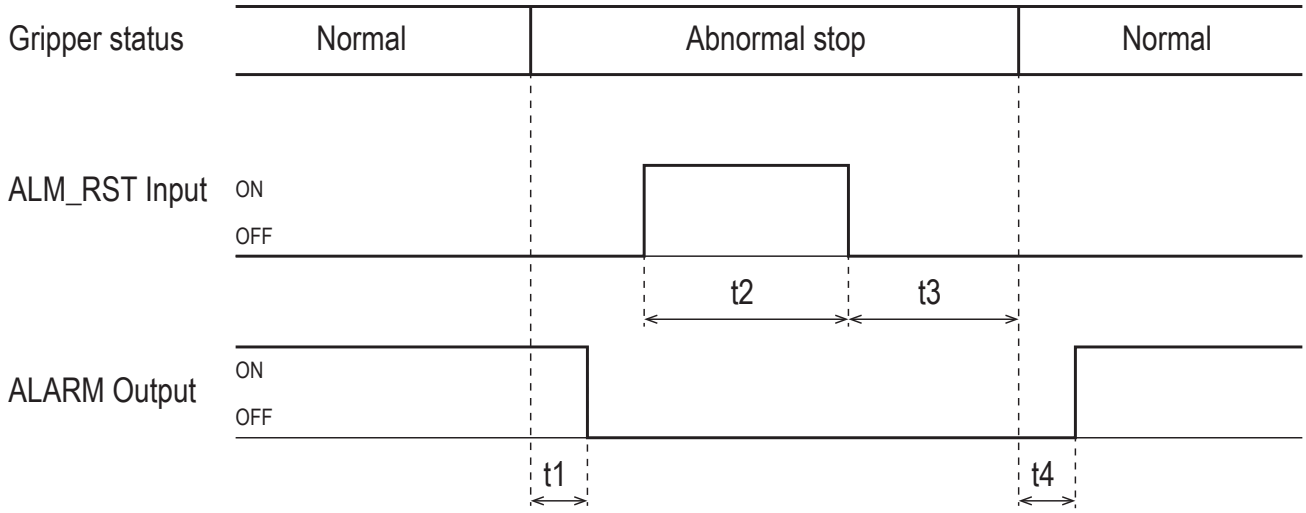
5.7.4. STOP Input



Symbols	Description	Units	Min	Typ	Max
t1	Finalize time after STOP Input signal is ON	msec	10	—	—
t2	Decelerating time to stop	msec	—	100	—
t3	Delay time after READY Output signal is ON	msec	—	—	5

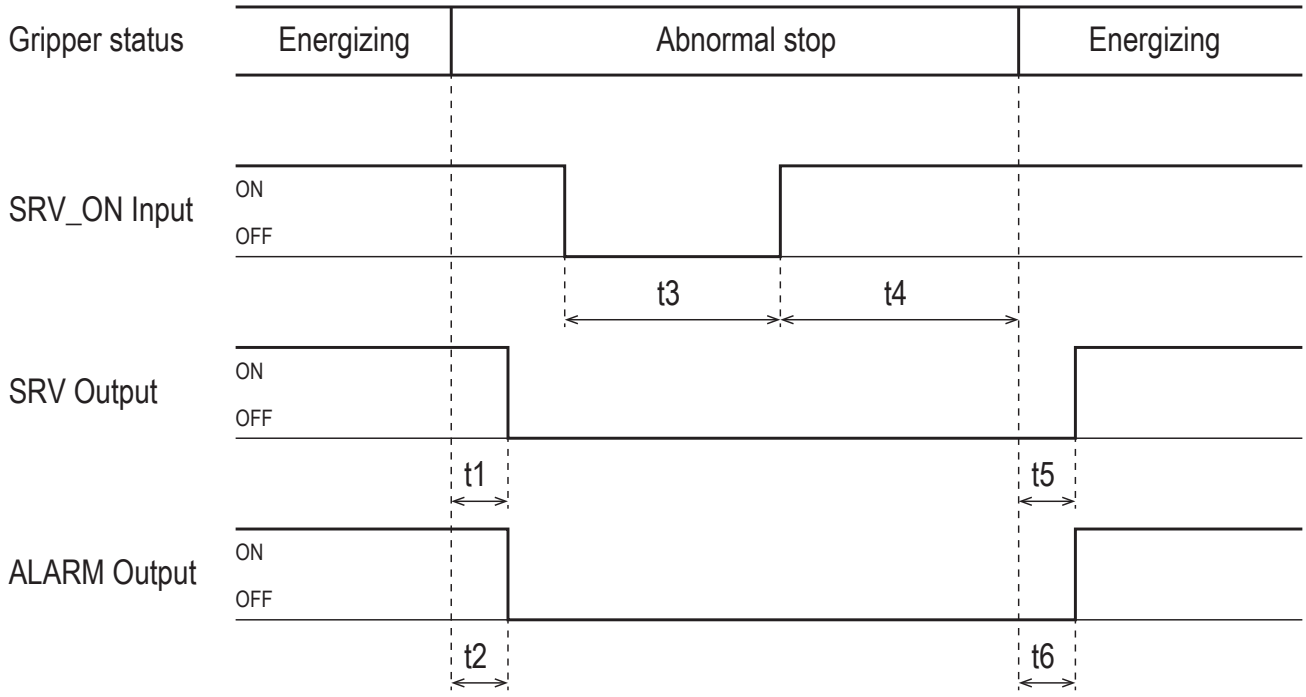
5.7.5. ALM_RST Input

5.7.5.1. Alarm reset by ALM_RST Input



Symbols	Description	Units	Min	Typ	Max
t1	Delay time after ALARM Output signal is OFF	msec	—	—	5
t2	Finalize time after ALM_RST Input signal is ON	msec	10	—	—
t3	Finalize time after ALM_RST Input signal is OFF	msec	10	—	—
t4	Delay time after ALARM Output signal is ON	msec	—	—	5

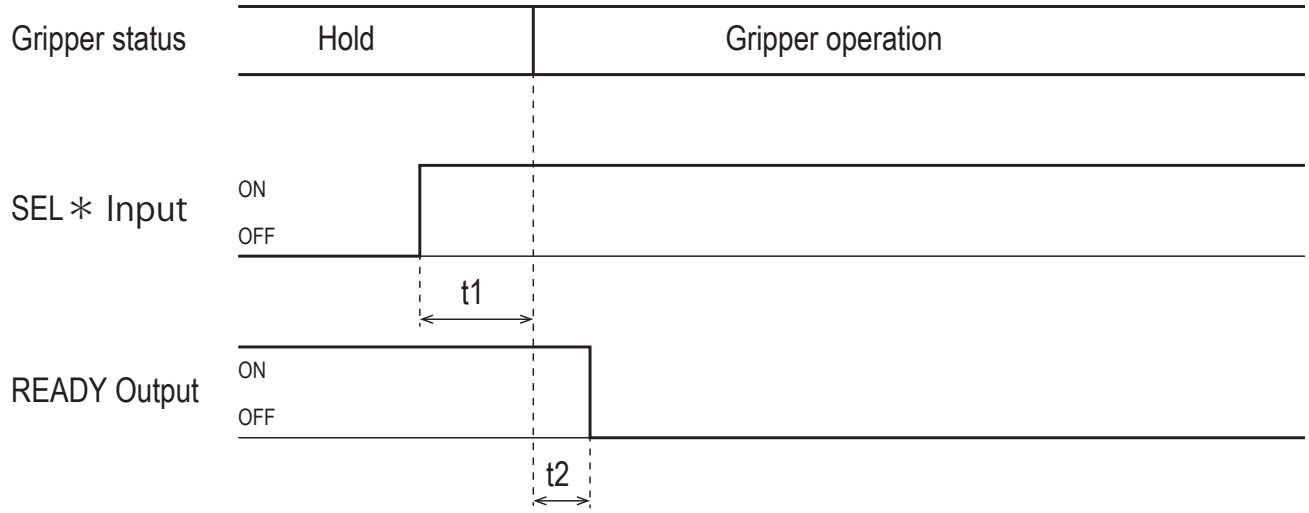
5.7.5.2. Alarm reset by SRV_ON signal when ALM_RST Input signal is invalid



Symbols	Description	Units	Min	Typ	Max
t1	Delay time after SRV Output signal is OFF	msec	—	—	5
t2	Delay time after ALARM Output signal is OFF	msec	—	—	5
t3	Finalize time after SRV_ON Input signal is OFF	msec	10	—	—
t4	Finalize time after SRV_ON Input signal is ON	msec	10	—	—
t5	Delay time after SRV Output signal is ON	msec	—	—	5
t6	Delay time after ALARM Output signal is ON	msec	—	—	5

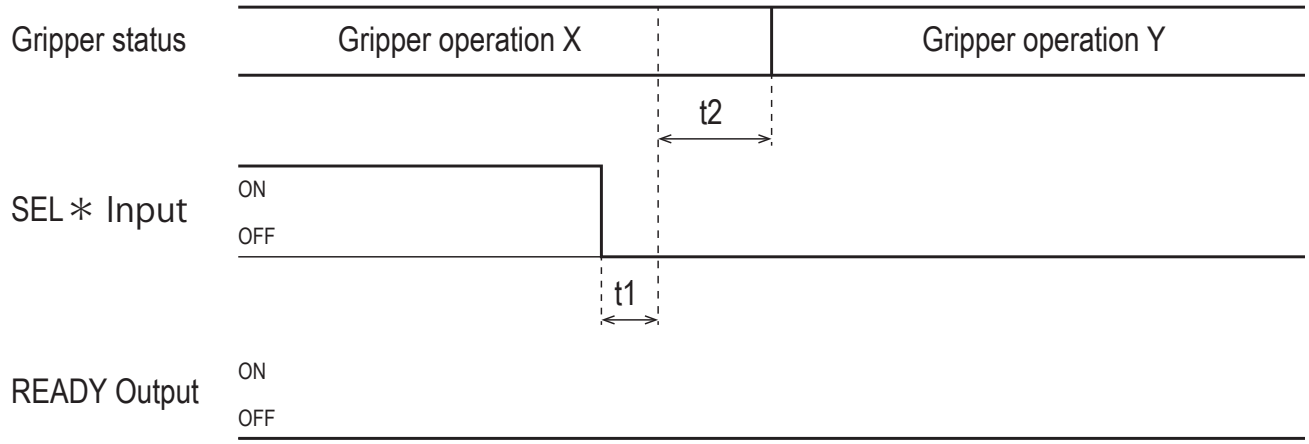
5.7.6. SEL0 to SEL2 Input

5.7.6.1. Gripper start up by SEL ∗ Input



Symbols	Description	Units	Min	Typ	Max
t1	Finalize time after SEL ∗ Input signal is ON	msec	10	—	—
t2	Delay time after READY Output signal is OFF	msec	—	—	5

5.7.6.2. Switch operation by SEL ∗ Input signal



Gripper operation X, Y : X = 0 to 7, Y ≠ X

Symbols	Description	Units	Min	Typ	Max
t1	Finalize time after SEL ∗ Input signal is OFF	msec	10	—	—
t2	Decelerating time to stop	msec	—	100	—

6. Gripper specifications

6.1. Robotic gripper

Items	Description
Maximum opening diameter	φ143mm
Grip force *1	50N
Maximum picking weight *2	500g
Maximum gripping weight *3	3000g
Open/close speed per the maximum stroke	0.8 to 10 sec
Maximum finger length	100mm
Repeatability accuracy at no load	±50μm
Size	φ60 x 155mm
Lifetime	10 million times of open/close motion at no load
Input voltage	24V ± 10%
Maximum current in rated operation	0.6A Max Peak
Maximum current in start up	0.6A Max
Weight	640g
Connection to robots	Connectable to each robot with optional attachment that will be developed in series *4

*1. At 30mm finger point away from the center of the finger rotation.

*2. At 70mm finger tips away from the center of the finger rotation. Distance may vary depending on material of the finger.

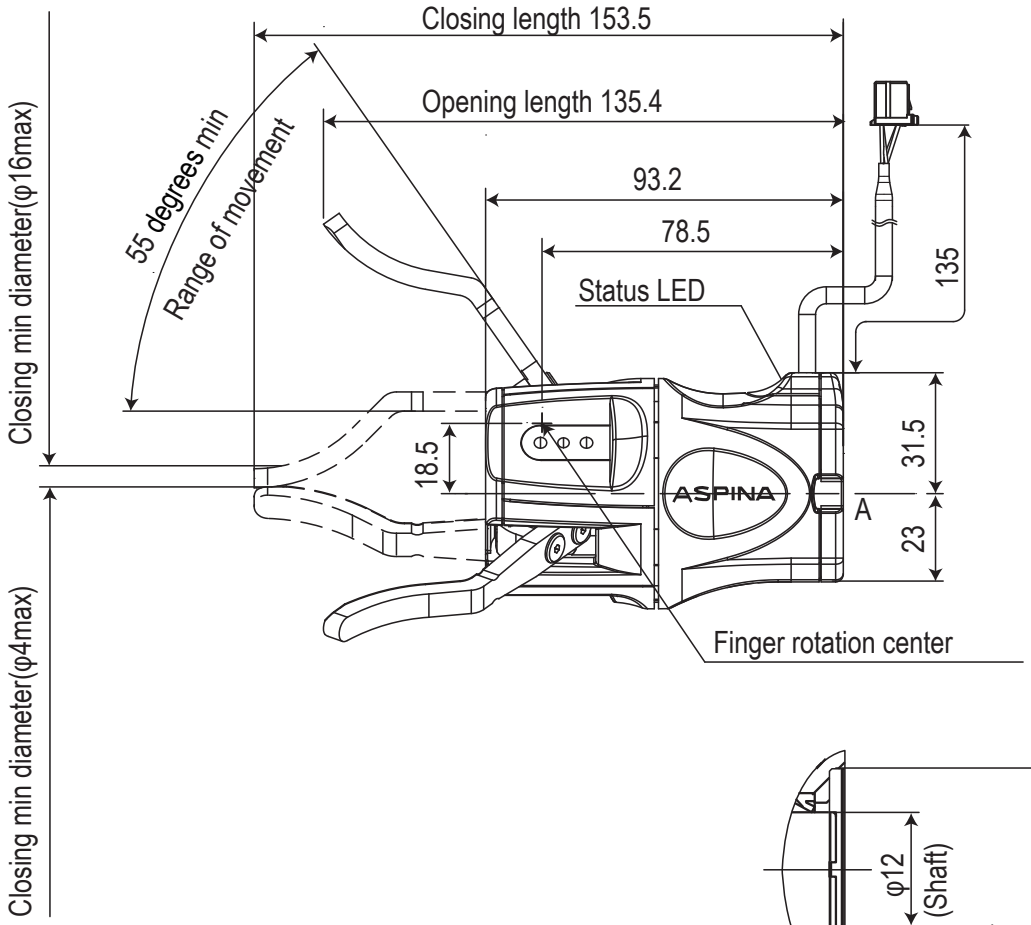
*3. At 30mm finger points away from the center of the finger rotation. Distance may vary depending on material of the finger.

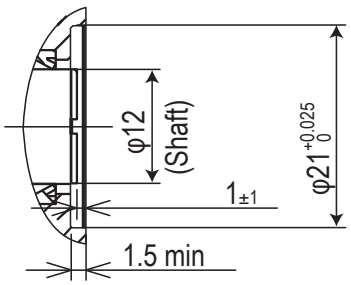
*4. Preparation of an attachment at customer side is necessary when connecting the gripper to a robot that is not supported with our attachments.

6.2. Outline

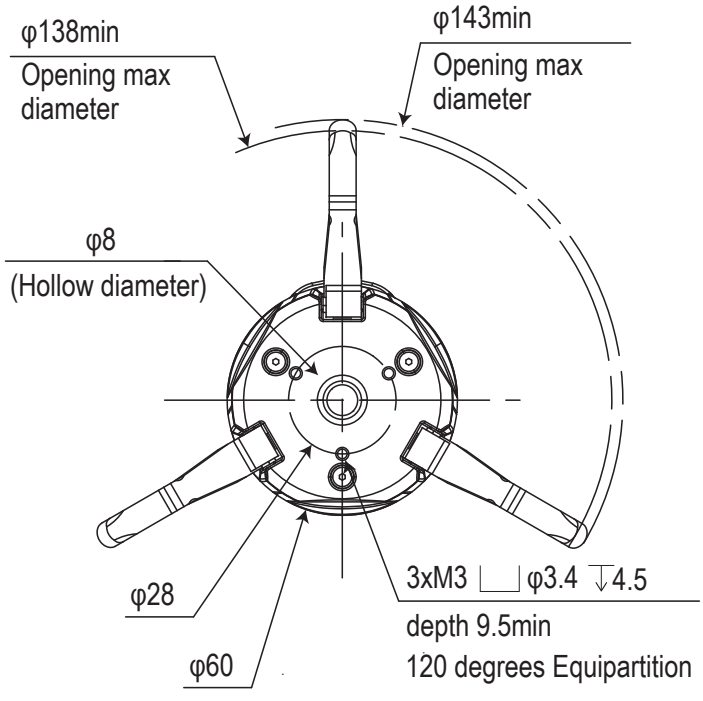
6.2.1. Main body with standard fingers

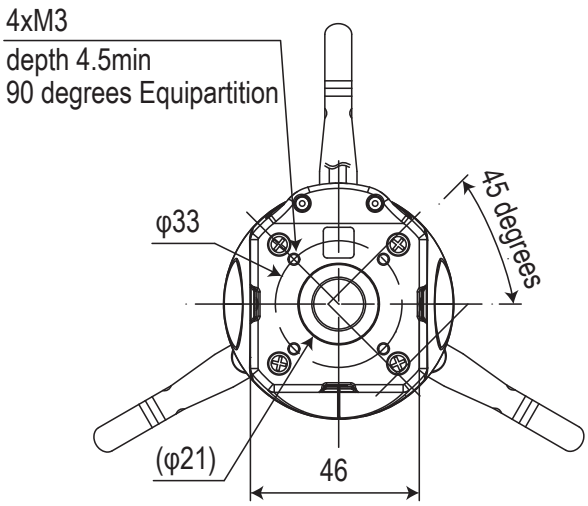
The dimensions are applicable to the main body with standard fingers.



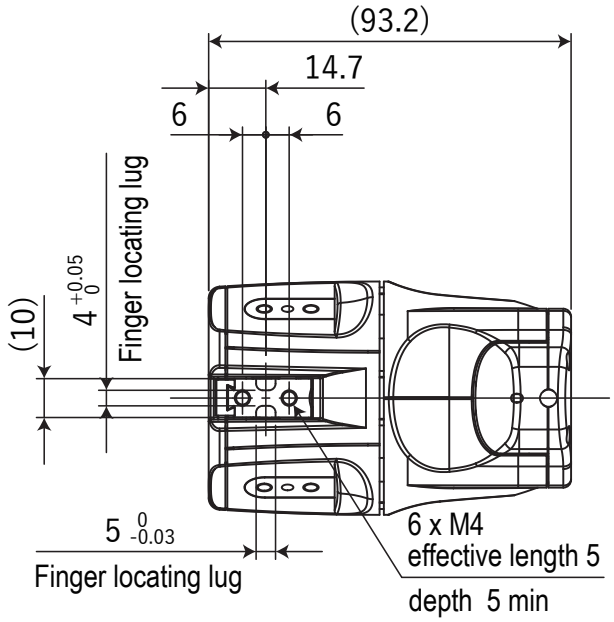


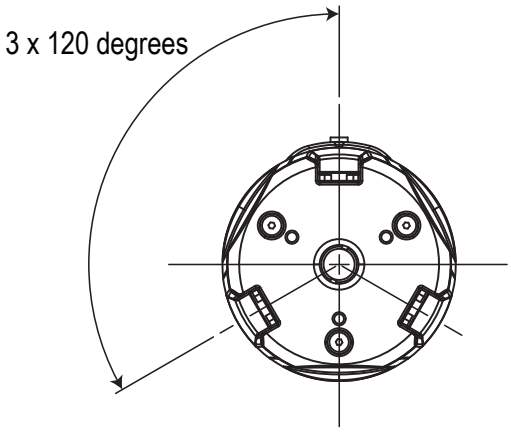
DETAIL A

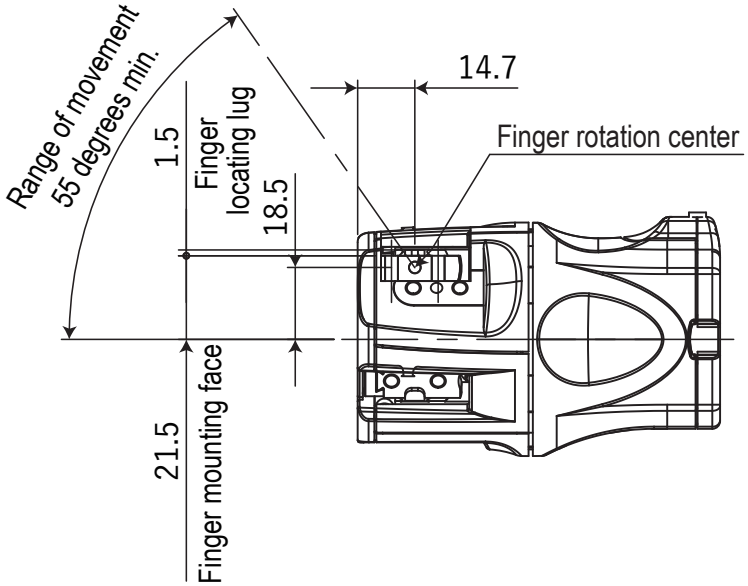


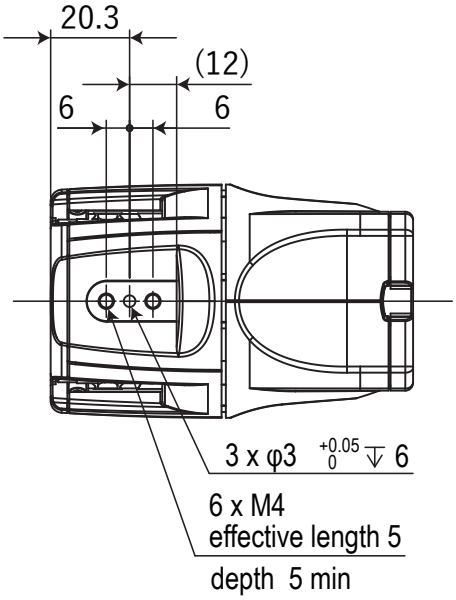


6.2.2. Main body without fingers

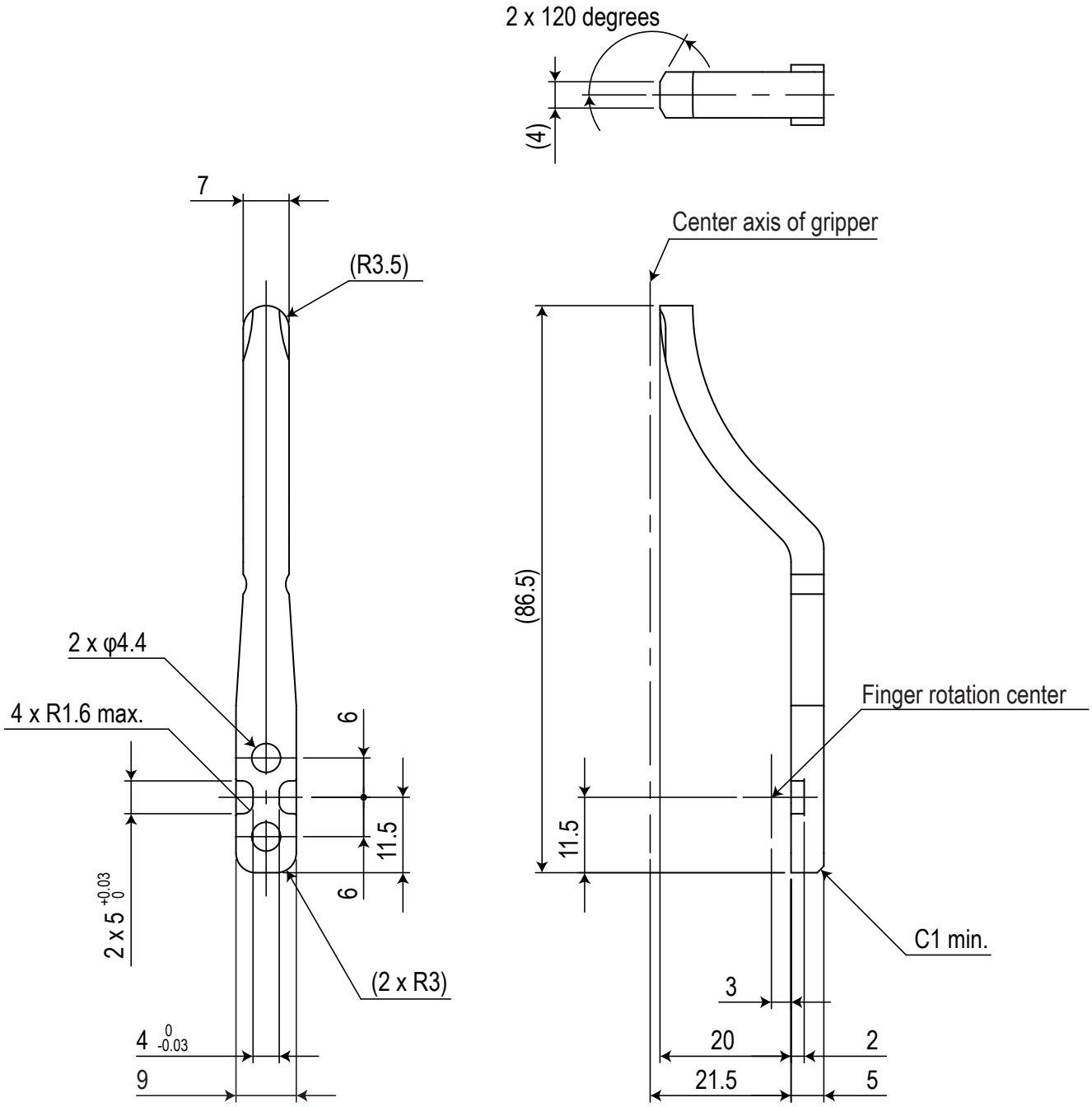








6.2.3. Standard finger



Restrictions in finger designing

- 100mm max. The distance between the finger rotation center and the gripping point.
- Please consider the finger weight per finger according to your usage conditions.

For use with the standard fingers

The applicable grip can be expanded by installing the included anti-slip tube or adding anti-slip by the customer.
Standard fingers are consumable items. Please consider the material and shape of fingers according to your usage conditions.
Use the attached screw (TRX Slim Head Machine Screw M4 x 10) to fix the standard finger.
If the thickness of the screw head exceeds 1 mm, it may interfere with the body.

6.3. Operation specifications

6.3.1. Open/close motion

The gripper has two operation types.
“Positioning operation” is used to move the fingers to the target position.
“Push-in operation” is used to move the fingers on to the extra target position after arriving at the target position.

6.3.1.1. Positioning operation

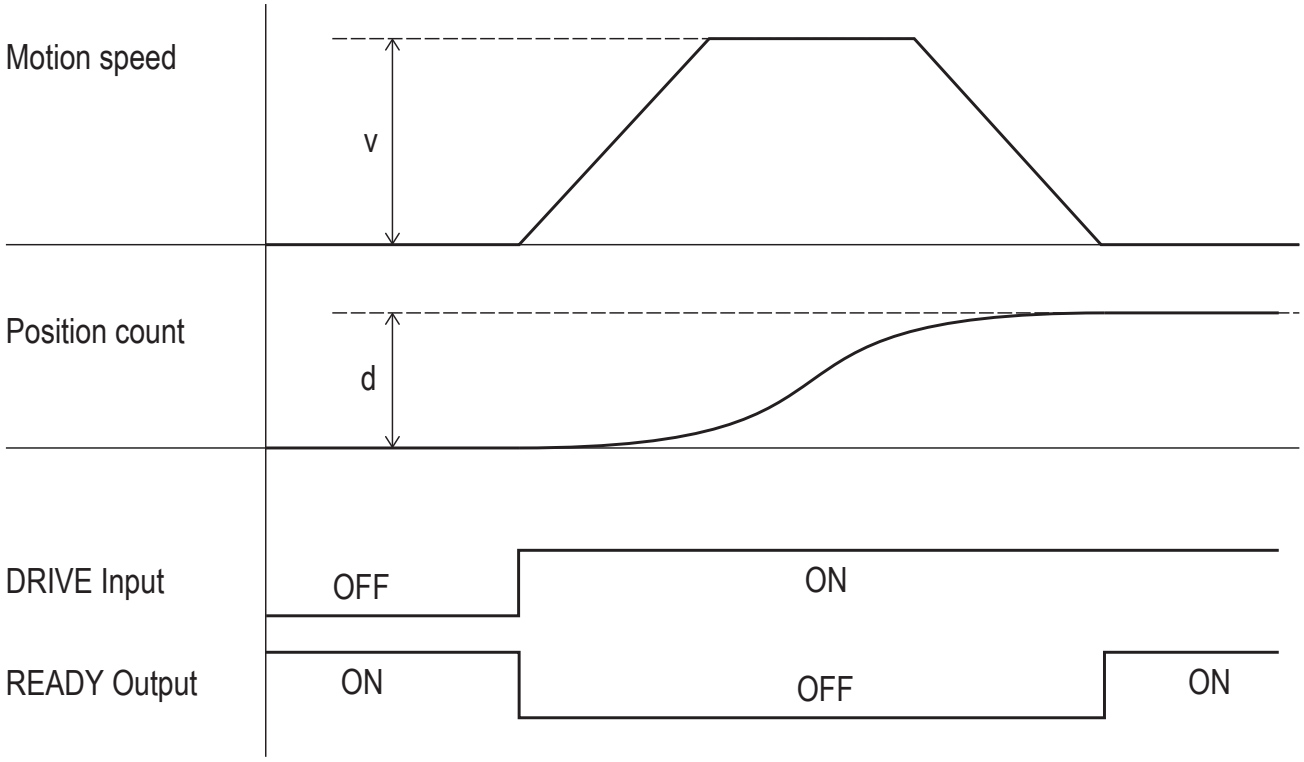
Parameters used in the positioning operation

Parameter name	Description
Target position	Target position to stop in unit of permillage 0.1 %
Operation time	Moving time to 0% position from 100% position in unit of msec
Positioning torque limit	Upper torque limit value in operating in unit of permillage 0.5 %

0.0% corresponds to the full open position and 100.0% corresponds to the full close position.

The target position can be set up to 110%.
When the target position exceeds 100%, the fingers interfere with each other and do not reach the target position. The robotic gripper continues to generate torque with the robotic gripper closed.

Positioning operation from 0% position with no gripping.



d: Moving distance to the target position from the 0% position
v: Attained speed automatic calculated from the operation time

6.3.1.2. Push-in operation

Dedicated parameters to the push-in operation are necessary in addition to parameters for the positioning operation.
Parameters used in the push-in operation.

Parameter names	Description
Push-in amount	Moving distance in unit of permillage 0.1 % after positioning
Push-in speed	Speed in the push-in operation in unit of permillage 0.1 %
Push-in torque limit	Upper limit torque in the push-in operation in unit % and 0.5 step size

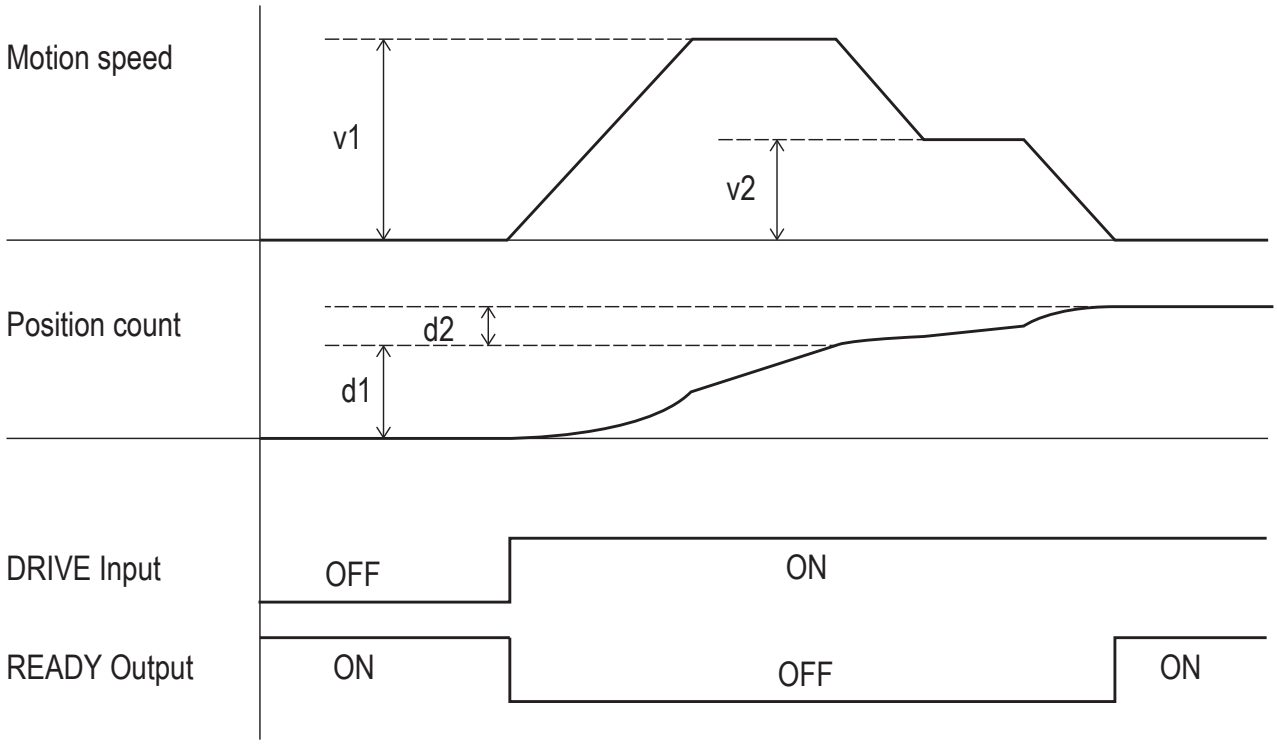
The push-in amount is a moving distance of the finger in addition to the positioning operation. The final position (Target position + Push-in amount) is restricted up to 110%.
The fingers stop gradually at the 110% position even though the push-in amount is set to higher than 110%.

Use plus sign or minus sign to set push-in direction. The plus sign compresses the finger to closing direction and the minus sign compresses to opening direction.

Set the push-in speed in unit %. 100% speed corresponds to 60 degrees/sec movement speed of the robotic gripper finger.

- When any one of the three parameters is set to 0, type of operation switches to the positioning operation.

Positioning operation from 0% position with no gripping.



d1: Moving distance to the target position from the 0% position
d2: Push-in amount
v1: Attained speed automatic calculated from the operation time
v2: Push-in speed

6.4. Power saving grip

While gripping the workpiece, the robotic gripper consumes power to maintain gripping force. After a certain period of time, Overheating abnormality may be detected due to the heat of the robotic gripper.

The robotic gripper has a self-locking mechanism, it maintains gripping force even when the power is reduced. This structure sets a limit on the amount of time that torque can be applied. Power saving grip is a function that lowers the output torque over time.

Power saving grip can be adjusted with parameters. The parameters are as follows.

Power saving grip output time	Set the time from the completion of positioning operation to torque reduction in milliseconds

When power saving grip is enabled, gripper measures the time after the positioning operation is completed and the standby state is entered, and the torque is reduced at the specified time.

In the case of push-in operation, gripper measures the time after the operation for the amount of pushing is completed and the standby state is entered, and the torque is reduced at the specified time.

- The default setting for power saving grip at the time of product shipment is set to power saving grip output time = 1000 ms. Power is saved after 1 second has passed since the workpiece was gripped.
- You can disable the function by setting the power saving grip output time to 0 ms.In that case, handle it so that the robotic gripper does not hold it for a long time.
- When the power saving grip is ON, the robotic gripper does not move in the closing direction even if there is no grip.

6.5. Emergency stop

The emergency stop method is as follows.

6.5.1. For I / O control

Turn on the STOP input.
Turn off the SRV ON input.

6.5.2. For communication control

Send a STOP instruction.

7. Communication

7.1. Type

7.1.1. Protocol

The gripper uses RS-485 as physical layer and Modbus as communication protocol.

7.1.2. Specifications

Items		Description
Communication interface	Communication standard	RS-485, 2 wires type
	Communication protocol	Modbus RTU
Transmission rate *1		9600, 19200, 38400, 57600, 115200, 230400 [bps]
Transmission method		Asynchronous half duplex communication
Data frame	Start bit	1 bit
	Data bit	8 bit
	Stop bit	1 bit
	Parity bit	Even
Termination resistor		Selectable via communication *2

*1. The default setting is 115,200 [bps].

*2. The default setting is “enable”.

7.2. List of Modbus function codes

The Modbus function codes in the gripper operation.

Function codes in hex	Function names	Description
0x03	Read Holding Register	The code is used to read the contents in the specified number of the holding register starting from the specified address
0x04	Read Input Register	The code is used to read the contents in the specified number of the input register starting from the specified address
0x06	Write Single Register	The code is used to write the contents in the single holding register of the specified address
0x10	Write Multiple Registers	The code is used to write the contents in the specified number of the holding register starting from the specified address

A function code is a command code specified for Modbus RTU communication.

When the command is executed correctly, OK response is returned to the master. In case of not, NG response is returned.

The holding register is used as setting information in the device.

The input register is used as status information in the device, and is subject only to reference, not to change.

7.2.1. Read Holding Register (03)

The code is used to read the contents in the specified number of the holding register starting from the specified address.
The number to reading register is up to 125.
The maximum number of the holding register is 9,999 and the address 0 to 9,998 is the range to be readable.

Data to send request

Item	Data size	Contents
Slave ID	1 byte	0x01 to 0x1F
Function code	1 byte	0x03
Head address	2 bytes	0x0000 to 0x270E
Register size to read *1	2 bytes	0x0001 to 0x007D
CRC code	2 bytes	—

Data to return OK

Item	Data size	Contents
Slave ID	1 byte	0x01 to 0x1F
Function code	1 byte	0x03
Byte count for reading data	1 byte	0x02 to 0xFA
Reading data	N bytes	
CRC code	2 bytes	—

Data to return NG

Item	Data size	Contents
Slave ID	1 byte	0x01 to 0x1F
Error code	1 byte	0x83
Exception response code	1 byte	0x01 to 0x04
CRC code	2 bytes	—

*1. Set the register size in unit of one word.

Refer to Section 7.5. for the list of the holding registers.
Refer to Section 7.2.5. for the exception response code.
Refer to Section 7.7.2. for the CRC code.

7.2.2. Read Input Resister (04)

The code is used to read the contents in the specified number of the input register starting from the specified address.The number to reading register is up to 125.
The maximum number of the input register is 9,999 and the address 0 to 9,998 is the range to be readable.

Data to send request

Item	Data size	Contents
Slave ID	1 byte	0x01 to 0x1F
Function code	1 byte	0x04
Head address	2 bytes	0x0000 to 0x270E
Register size to read *1	2 bytes	0x0001 to 0x007D
CRC code	2 bytes	—

Data to return OK

Item	Data size	Contents
Slave ID	1 byte	0x01 to 0x1F
Function code	1 byte	0x04
Byte count for reading data	1 byte	0x02 to 0xFA
Reading data	N bytes	
CRC code	2 bytes	—

Data to return NG

Item	Data size	Contents
Slave ID	1 byte	0x01 to 0x1F
Error code	1 byte	0x84
Exception response code	1 byte	0x01 to 0x04
CRC code	2 bytes	—

*1. Set the register size in unit of one word.

Refer to Section 7.4. for the list of the input registers.
Refer to Section 7.2.5. for the exception response code.
Refer to Section 7.7.2. for the CRC code.

7.2.3. Write Single Register (06)

The code is used to write the contents in the single holding register of the specified address.
The address 0 to 9,998 is the range to be writable.

Data to send request

Item	Data size	Contents
Slave ID	1 byte	0x01 to 0x1F
Function code	1 byte	0x06
Register address	2 bytes	0x0000 to 0x270E
Writing data	2 bytes	0x0000 to 0xFFFF
CRC code	2 bytes	–

Data to return OK

Item	Data size	Contents
Slave ID	1 byte	0x01 to 0x1F
Function code	1 byte	0x06
Writing address	2 bytes	0x0000 to 0x270E
Writing data	2 bytes	0x0000 to 0xFFFF
CRC code	2 bytes	–

Data to return NG

Item	Data size	Contents
Slave ID	1 byte	0x01 to 0x1F
Error code	1 byte	0x86
Exception response code	1 byte	0x01 to 0x04
CRC code	2 bytes	–

Refer to Section 7.5. for the list of the holding registers.
Refer to Section 7.2.5. for the exception response code.
Refer to Section 7.7.2. for the CRC code.

7.2.4. Write Multiple Registers (10)

The code is used to write the contents in the specified number of the holding register starting from the specified address.
The number to writing register is up to 125.
The address 128 to 9,998 is the range to be multiple writable.
The address 0 to 127 is prohibited to write in multiple registers.

Data to send request

Item	Data size	Contents
Slave ID	1 byte	0x01 to 0x1F
Function code	1 byte	0x10
Head address	2 bytes	0x0080 to 0x270E
Register size to read *1	2 bytes	0x0001 to 0x007B
Byte count of writing data	1 byte	0x02 to 0xF6
Writing data	N bytes	
CRC code	2 bytes	—

Data to return OK

Item	Data size	Contents
Slave ID	1 byte	0x01 to 0x1F
Function code	1 byte	0x10
Head address	2 bytes	0x0080 to 0x270E
Register size to write	2 bytes	0x0001 to 0x007B
CRC code	2 bytes	—

Data to return NG

Item	Data size	Contents
Slave ID	1 byte	0x01 to 0x1F
Error code	1 byte	0x90
Exception response code	1 byte	0x01 to 0x04
CRC code	2 bytes	—

*1. Set the register size in unit of one word.

Refer to Section 7.5. for the list of the holding registers.
Refer to Section 7.2.5. for the exception response code.
Refer to Section 7.7.2. for the CRC code.

7.2.5. Exception response code

The exception response codes applicable to the gripper.

Exception code in hex	Cause of the exception	Countermeasure
0x01	Function code other than applicable function code was received	Send a proper code in accordance with this manual
0x02	An address out of the effective range was received	Set the address within the effective range in accordance with this manual
0x03	Any of following cases • Disaccord of the number of the reading or writing data • The number of the register is 0 • The number of bytes is not twice of the number of registers • The number of data is out of the range • The length of data is out of the range	Check the writing data is within the range
0x04	Inexecutable command	Execute ALARM_RST when the command is not accepted in alarm stopping The startup command is not accepted in gripper no energized Try again after energized The exception response 04 is returned against the command with the same operation number as the last number

7.3. Communication examples

Examples of sending/receiving communication commands through Modbus RTU.

The device at the gripper side is a slave and the host device controlling the gripper is a master. “Request” is defined as a sending process to the slave from the master and “Response” is defined as a returning process to the master from the slave.
The subsequent sections describe the communication examples.

7.3.1. Operation parameter setting 0x1200 to 0x1202 to set the parameters of gripper operation.
7.3.2. Operation instruction 0x0010 to order startup to the gripper.
7.3.3. Status referral 0x0026 to 0x002A to refer to the internal status.
7.3.4. EEPROM operation 0x0050 to store the operation parameters in the EEPROM.
7.3.5. Product information referral 0x0008 to refer to the gripper information.

7.3.1. Operation parameter setting 0x1200 to 0x1202

Use the command to adjust position and time in open/close motion.
The following example introduces the parameter setting of the operation number 2.
The target position is 50%, the operation time is 1sec and the grip torque of the finger is 75%.
Register addresses are 0x1200 to 0x1202.
Use “Write Multiple Registers” to set the multiple parameters at a time.

7.3.1.1. Target position, operation time and torque setting in the operation number 2

Request example: 01, 10, 12, 00, 00, 03, 06, 01, F4, 03, E8, 02, EE, 08, A0

Data in hex	Description
0x01	Slave ID = 1
0x10	Function code = Write Multiple Registers (10)
0x1200	Address = 0x1200
0x0003	Register size = 3 words
0x06	Byte count = 6 bytes
0x01F4	Target position = 50%
0x03E8	Operation time for full stroke = 1,000 msec
0x02EE	Torque limit in positioning operation = 75%
0x08A0	CRC code

Response example: 01, 10, 12, 00, 00, 03, 85, 70

Data in hex	Description
0x01	Slave ID = 1
0x10	Function code = Write Multiple Registers (10)
0x1200	Head address = 0x1200
0x0003	Register size = 3 words
0x8570	CRC code

7.3.2. Operation instruction 0x0010

Use the command to startup the gripper.
Subsections from 7.3.2.1. to 7.3.2.3. introduce the example of request/respond in the operation number 0 to 2. The register address is 0x0010 in either cases.
Use “Write Single Register” as an operation command.

7.3.2.1. Start the operation number zero

Request example: 01, 06, 00, 10, 00, 90, 88, 63

Data in hex	Description
0x01	Slave ID = 1
0x06	06 Function code = Write Single Register (06)
0x0010	Address = 0x0010
0x0090	Operation ID = 0x90 to start the operation number zero
0x8863	CRC code

The command is OK
Response example: 01, 06, 00, 10, 00, 90, 88, 63

Date in hex	Description
0x01	Slave ID = 1
0x06	Function code = Write Single register (06)
0x0010	Address
0x0090	Operation ID = 0x90 to start the operation number 0
0x8863	CRC code

The command is NG
Response example: 01, 86, 04, 43, A3

Data in hex	Description
0x01	Slave ID = 1
0x86	Error code = 128 + Write Single Register (06)
0x04	Exception response code = 0x04 for the inexecutable command
0x43A3	CRC code

7.3.2.2. Start the operation number 1

Request example: 01, 06, 00, 10, 00, 91, 49, A3

Data in hex	Description
0x01	Slave ID = 1
0x06	Function code = Write Single Register (06)
0x0010	Address = 0x0010
0x0091	Operation ID = 0x91 to start the operation number 1
0x49A3	CRC code

The command is OK

Response example: 01, 06, 00, 10, 00, 91, 49, A3

Data in hex	Description
0x01	Slave ID = 1
0x06	Function code = Write Single Register (06)
0x0010	Address = 0x0010
0x0091	Operation ID = 0x91 to start the operation number 1
0x49A3	CRC code

The command is NG

Response example: 01, 86, 04, 43, A3

Data in hex	Description
0x01	Slave ID = 1
0x86	Error code = 128 + Write Single Register (06)
0x04	Exception response code = 0x04 for the inexecutable command
0x43A3	CRC code

7.3.2.3. Start the operation number 2

Request example: 01, 06, 00, 10, 00, 92, 09, A2

Data in hex	Description
0x01	Slave ID = 1
0x06	Function code = Write Single Register (06)
0x0010	Address = 0x0010
0x0092	Operation ID = 0x92 to start the operation number 2
0x09A2	CRC code

The command is OK

Response example: 01, 06, 00, 10, 00, 92, 09, A2

Data in hex	Description
0x01	Slave ID = 1
0x06	Function code = Write Single Register (06)
0x0010	Address = 0x0010
0x0092	Operation ID = 0x92 to start the operation number 2
0x09A2	CRC code

The command is NG

Response example: 01, 86, 04, 43, A3

Data in hex	Description
0x01	Slave ID = 1
0x86	Error code = 128 + Write Single Register (06)
0x04	Exception response code = 0x04 for the inexecutable command
0x43A3	CRC code

7.3.3. Status referral 0x0026 to 0x002A

Use the command to refer to the internal status of the gripper via communication.
Section 7.3.3.1. describes the example to refer to the torque, the finger speed, the finger position, the voltage level and the temperature of the gripper. The register addresses are 0x0026 to 0x002A.
Section 7.3.3.2. describes the example to refer to the internal status of the gripper in bit data. The register addresses are 0x0024 and 0x0025.
"Read Input Register" is used in the status referral.

7.3.3.1. Status referral

Request example: 01, 04, 00, 26, 00, 05, D1, C2

Data in hex	Description
0x01	Slave ID = 1
0x04	Function code = Read Input Register (04)
0x0026	Address = 0x0026
0x0005	Register size = 5 words
0xD1C2	CRC code

Response example: 01, 04, 0A, FF, 97, FC, 05, 00, 56, 00, ED, 00, 2D, 2C, 8D

Data in hex	Description
0x01	Slave ID = 1
0x04	Function code = Read Input Register (04)
0x0A	Data byte count = 10 bytes
0xFF97	Current torque = -10.5% *1
0xFC05	Current speed = -101.9 % *1
0x0056	Current position = 8.6%
0x00ED	Internal voltage level = 23.7V
0x002D	Temperature of the thermistor = 45 degree C
0x2C8D	CRC code

*1. The negative value is indicated by "a complement number of 2"with the least significant bit as 1. Closing direction is defined as plus and opening direction is defined as minus.

7.3.3.2. Gripper bit status referral

Request example: 01, 04, 00, 24, 00, 02, 31, C0

Data in hex	Description
0x01	Slave ID = 1
0x04	Function code = Read Input Register (04)
0x0024	Address = 0x0024
0x0002	Register size = 2 words
0x31C0	CRC code

Response example: 01, 04, 04, 00, 00, 01, A3, BA, 6D

Data in hex	Description
0x01	Slave ID = 1
0x04	Function code = Read Input Register (04)
0x04	Data byte count = 4 bytes
0x000001A3	Gripper bit status = 0x000001A3 But 0 = 1: In energizing Bit 1 = 1: In ready Bit 2 = 0: No alarm Bit 3 = 0: GRIP_ERR Output is OFF Bit 5 = 1: EEPROM is in ready and waiting Bit 6 = 0: AREA Output is OFF Bit 7 = 1: Origin return operation is completed Bit 8 to 11 =1: In hold operation
0xBA6D	CRC code

7.3.4. EEPROM operation 0x0050

The parameters stored in the EEPROM is applied at reboot.
Section 7.3.4.1. describes the example to store the operation number 0 to 3 at a time.
Section 7.3.4.2. describes the example to initialize all parameters stored in the EEPROM and to restore to the default.
The register address is 0x0050 in either cases.
"Write Single Register" is used in the EEPROM operation.

7.3.4.1. Storage of operation parameters

Request example: 01, 06, 00, 50, 00, 10, 88, 17

Data in hex	Description
0x01	Slave ID = 1
0x06	Function code = Write Single Register (06)
0x0050	Address = 0x0050
0x0010	EEPROM access ID = 0x10 to store the operation parameter 0 to 3
0x8817	CRC code

The command is OK
Response example: 01, 06, 00, 50, 00, 10, 88, 17

Data in hex	Description
0x01	Slave ID= 1
0x06	Function code = Write Single Register (06)
0x0050	Address = 0x0050
0x0010	EEPROM access ID = 0x10 to store the operation parameter 0 to 3
0x8817	CRC code

The command is NG
Response example: 01, 86, 04, 43, A3

Data in hex	Description
0x01	Slave ID = 1
0x86	Error code = 128 + Write Single Register (06)
0x04	Exception response code = 0x04 for inexecutable command
0x43A3	CRC code

7.3.4.2. Initialization of all parameters in EEPROM

Request example: 01, 06, 00, 50, 00, 7F, C8, 3B

Data in hex	Description
0x01	Slave ID = 1
0x06	Function code = Write Single Register (06)
0x0050	Address = 0x0050
0x007F	EEPROM access ID = 0x7F to restore the all parameters to the default
0xC83B	CRC code

The command is OK

Response example: 01, 06, 00, 50, 00, 7F, C8, 3B

Data in hex	Description
0x01	Slave ID = 1
0x06	Function code = Write Single Register (06)
0x0050	Address = 0x0050
0x007F	EEPROM access ID = 0x7F to restore the all parameter to the default
0xC83B	CRC code

The command is NG

Response example: 01, 86, 04, 43, A3

Data in hex	Description
0x01	Slave ID = 1
0x86	Error code = 128 + Write Single Register (06)
0x04	Exception response code = 0x04 for inexecutable command
0x43A3	CRC code

7.3.5. Product information referral 0x0008

Use the command to refer to the product information via communication.
Following is the example to refer to the version information of the firmware.
Register address is 0x0008.
"Read Input Register" is used for the status referral.

7.3.5.1. Referral of the firmware version

Request example: 01, 04, 00, 08, 00, 01, B0, 08

Data in hex	Description
0x01	Slave ID = 1
0x04	Function code = Read Input Register (04)
0x0008	Address = 0x0008
0x0001	Register size = 1 word
0xB008	CRC code

Response example: 01, 04, 02, 27, 10, A3, 0C

Data in hex	Description
0x01	Slave ID = 1
0x04	Function code = Read Input Register (04)
0x02	Data byte count = 2 bytes
0x2710	Firmware version = 10000
0xA30C	CRC code

7.4. Read only register

Use the command “Read Input Register (04)”to get the read only register.

7.4.1. Common parameters check

Addres in hex	Data length	Name	Description
0x0000 0x0001 0x0002 0x0003 0x0004 0x0005 0x0006 0x0007	8	Product name	The product name that is described by up to 15 half-width alphanumeric
0x0008	1	Firmware version	The firmware version that is described by 5 digits number
0x0009	1	Reserved	Reserved
0x000A	1	Firmware build year	The year that the firmware was built
0x000B	1	Firmware build month	The month that the firmware was built
0x000C	1	Firmware build day	The day that the firmware was built
0x000D	1	Firmware build hour	The hour that the firmware was built
0x000E	1	Firmware build minute	The minute that the firmware was built
0x000F	1	Firmware build second	The second that the firmware was built
0x0010	1	Reserved	Reserved
0x0011	1	Reserved	Reserved
0x0012	1	Reserved	Reserved
0x0013	1	Reserved	Reserved
0x0014	1	Reserved	Reserved
0x0015	1	Reserved	Reserved
0x0016	1	Reserved	Reserved
0x0017	1	Reserved	Reserved

7.4.2. Status referral

Address in hex	Data length	Name	Description
0x0020	2	Alarm bit status in higher order	The abnormal item is indicated by 32 bit data
0x0021		Alarm bit status in lower order	Refer to Section 7.5. for the details of the reading data
0x0022	1	Reserved	Reserved
0x0023	1	Reserved	Reserved
0x0024	2	Gripper bit status in higher order	The gripper status is indicated by 32 bit data
0x0025		Gripper bit status in lower order	Refer to Section 7.6. for the details of the read data
0x0026	1	Current torque	Current torque
0x0027	1	Current speed	Current speed
0x0028	1	Current position	Current position
0x0029	1	Internal voltage level	The measured voltage level at the controller board [x 0.1 V]
0x002A	1	Thermistor	Temperature indicated by the thermistor on the board [Degree C]
0x002B	1	Reserved	Reserved
0x002C	1	Reserved	Reserved
0x002D	1	Finger motion angle	0: Noncompletion of the origin return operation Other than zero: The mechanical angle from the full-open to the full-close [x 0.1 degree]
0x002E	1	Finger current angle	Finger current angle
0x002F	1	Reserved	Reserved
0x0030	1	Command torque *1	Command torque
0x0031	1	Reserved	Reserved
0x0032	1	Command position *1	Command position
0x0033	1	Reserved	Reserved
0x0034	1	Reserved	Reserved
0x0035	1	Reserved	Reserved
0x0036	1	Reserved	Reserved
0x0037	1	Reserved	Reserved
0x0038	1	Status of input signal 1	0: Input OFF 1: Input ON -1: Input invalid
0x0039	1	Status of input signal 2	0: Input OFF 1: Input ON -1: Input invalid
0x003A	1	Status of input signal 3	0: Input OFF 1: Input ON -1: Input invalid
0x003B	1	Status of input signal 4	0: Input OFF 1: Input ON -1: Input invalid
0x003C	1	Reserved	Reserved
0x003D	1	Reserved	Reserved
0x003E	1	Reserved	Reserved
0x003F	1	Reserved	Reserved
0x0040	1	Reserved	Reserved
0x0041	1	Reserved	Reserved

Address in hex	Data length	Name	Description
0x0042	1	Status of output signal 3	0: Output OFF 1: Output ON -1: Output invalid
0x0043	1	Status of output signal 4	0: Output OFF 1: Output ON -1: Output invalid

*1. Torque, speed and position is indicated by permillage such as 0.0% or 100.0%. Refer to Section 7.7. for the details.

7.4.3. ARH350A Only

Address in hex	Data length	Name	Description
0x0100	1	Upper limit of target position	Upper limit of target position specified by operation parameters
0x0101	1	Lower limit of target position	Lower limit of target position specified by operation parameters
0x0102	1	Upper limit of operation time	Upper limit of operation time specified by operation parameters
0x0103	1	Lower limit of operation time	Lower limit of operation time specified by operation parameters
0x0104	1	Gear reduction ratio (motor)	Denominator of reduction ratio
0x0105	1	Gear reduction ratio (follower)	Numerator of reduction ratio

7.4.4. Alarm history

Address in hex	Data length	Name	Description
0x0200	1	Alarm record 0	The latest alarm record
0x0201	1	Alarm record 1	Alarm record
0x0202	1	Alarm record 2	Alarm record
0x0203	1	Alarm record 3	Alarm record
0x0204	1	Alarm record 4	Alarm record
0x0205	1	Alarm record 5	Alarm record
0x0206	1	Alarm record 6	Alarm record
0x0207	1	Alarm record 7	Alarm record
0x0208	1	Alarm record 8	Alarm record
0x0209	1	Alarm record 9	The oldest alarm record

The alarm records with 16 bit are stored in the alarm history. Refer to Section 7.6.5. for the details.

- CPU error and EEPROM error are not stored in the alarm history.

7.5. List of readable/writable registers

Use the command “Read Holding Register (03)”to get the readable/writable registers.
Use the command “Write Single Register (06)”to write to single address and “Write Multiple Register (10)”to write to multiple addresses.

7.5.1. Operation instruction

Address in hex	Data length	Name	Description
0x0000 to 0x000F	–	Reserved	Reserved
0x0010	1	Gripper operation ID	Set the ID corresponding to execute desired function Refer to Section 7.6.3. for the details of the writing data
0x0011 to 0x001F	–	Reserved	Reserved
0x0020	1	Registration of teaching position	Set the position of the finger tip of the stopping gripper as a coordinate of the target position in the specified operation number. The range of the writing data is 0 to 15
0x0021 to 0x002F	–	Reserved	Reserved
0x0030	1	Alarm reset	Use to cancel the alarm status The writing data is only zero
0x0031 to 0x004F	–	Reserved	Reserved
0x0050	1	EEPROM access ID	Set the area for update in EEPROM by the ID Refer to Section 7.6.4. for the details of the writing data
0x0051 to 0x005F	–	Reserved	Reserved
0x0060	1	Protect code	Code to modify protected data Unprotect the data when the input value matches the code
0x0061 to 0x007F	–	Reserved	Reserved

- Writing in multiple addresses is prohibited in the operation instruction. Use the command “Write Single Register (06)”for sending.
- The fingers do not move after the second time or later even through the command with the same operation number is transferred repeatedly by the gripper operation ID. Set different operation number for gripper motion.
- The teaching position is not registered, when the position is out of the range 0 to 100% that was obtained from the origin return operation.
- Do not use the data other than 0 in the alarm reset command. Also remove all causes of the alarm to cancel the alarm status.

7.5.2. Common parameters

Address in hex	Data length	Name	Range	Description	Default
0x0100	1	Slave ID	1 to 31	Communication ID	1
0x0101	1	Communication baud rate ID	6 to 11	Select communication speed Refer to Section 7.6.1. for the ID details	10
0x0102	1	Termination resistor	0 to 1	0: Without RS-485 termination resistor 1: With RS-485 termination resistor	1
0x0103	1	Reserved	—	Reserved	—
0x0104	1	Reserved	—	Reserved	—
0x0105	1	Reserved	—	Reserved	—
0x0106	1	Origin return operation at startup	0 to 1	0: No operation at startup 1: Start the origin return operation at startup	1
0x0107	1	Input / Output contact ID1	0 to 15, 256 to 271	Select a function for Input signal 1 Refer to Section 7.6.2. for the details	5
0x0108	1	Input / Output contact ID2	0 to 15, 256 to 271	Select a function for Input signal 2 Refer to Section 7.6.2. for the details	4
0x0109	1	Input / Output contact ID3	0 to 15, 256 to 271	Select a function for Input / Output signal 3 Refer to Section 7.6.2. for the details	259
0x010A	1	Input / Output contact ID4	0 to 15, 256 to 271	Select a function for Input / Output signal 4 Refer to Section 7.6.2. for the details	258

*1. Basically keep the default settings.

- Settings read from EEPROM at startup are applied to the common parameters. Make sure that the settings are effective using the Read command after parameter change and send the EEPROM storage command.
- Settings read from EEPROM at startup are applied to the slave ID, the baud rate and the termination resister. Keep the current communication settings until power off after the parameters changed.
- “System parameter error” is detected just after power ON, when the same ID is assigned to multiple input/output signal functions stored in EEPROM.
- Be sure to assign the SEL* Input signal to any of the input/output contact ID1 to ID4. Otherwise “System parameter error” is detected just after power ON.
- “System parameter error” is detected at power ON, when the contact ID that is defined as “system reserved” described in Section 7.6.2. is set and stored in the EEPROM.

7.5.3. Origin return operation

Address in hex	Data length	Name	Range	Description	Default
0x0200	1	Direction of origin return	-1 or 1	1: Firstly the gripper detects full-close position, and sets an origin position near the full-open position detected secondly -1: Firstly the gripper detects full-open position, and sets an origin position near the full-close position detected secondly	1
0x0201	1	Speed in origin return operation	100 to 1000 (10.0 to 100.0%)	Speed in origin return operation	500
0x0202	1	Acceleration in origin return operation	100 to 5000 (10.0 to 500.0%)	Acceleration in origin return operation	1000
0x0203	1	Reserved	—	Reserved	—

7.5.4. Protection function

Address in hex	Data length	Name	Range	Description	Default
0x0400	1	Energizing setting in over voltage	0 or 1	Setting 0 stops energizing the gripper once the over voltage is detected Setting 1 continues energizing the gripper even though the over voltage is detected.	0
0x0401	1	Energizing setting in ow voltage	0 or 1	Setting 0 stops energizing the gripper once the low voltage is detected Setting 1 continues energizing the gripper even though the low voltage is detected.	0
0x0402	1	Energizing setting in over heat	0 or 1	Setting 0 stops energizing the gripper once the over heat is detected Setting 1 continues energizing the gripper even though the over heat is detected	0
0x0403	1	Reserved	—	Reserved	—
0x0404	1	Reserved	—	Reserved	—
0x0405	1	Reserved	—	Reserved	—
0x0406	1	Reserved	—	Reserved	—
0x0407	1	Reserved	—	Reserved	—
0x0408	1	Output time of power saving grip	0 to 10000	Time to reduce torque [msec] (0 = power saving grip disabled)	1000
0x0409	1	Reserved	—	Reserved	—

7.5.5. Individual operation

7.5.5.1. Operation number 0

Address in hex	Data length	Name	Range	Description	Default
0x1000	1	Target position	0 to 1100 (0.0 to 110.0%)	Target position to stop the finger	0
0x1001	1	Operation time	800 to 10000	Moving time to 100% position from 0% position [msec]	1000
0x1002	1	Positioning torque limit	5 to 1000 (0.5 to 100.0%)	Torque limit in motion	800
0x1003	1	Push-in amount	-1000 to 1000 (-100.0 to 100.0%)	Moving distance in Push-in operation *1 (0 = Push-in operation is invalid)	0
0x1004	1	Push-in speed	0 to 1000 (0.0 to 100.0%)	Operation speed in Push-in operation (0 = Push-in operation is invalid)	0
0x1005	1	Push-in torque limit	0 to 1000 (0.0 to 100.0%)	Torque limit in Push-in operation (0 = Push-in operation is invalid)	0
0x1006	1	AREA Output range	0 to 1000 (0.0 to 100.0%)	Minimum value of AREA Output range	0
0x1007	1	AREA Output range	0 to 1000 (0.0 to 100.0%)	Maximum value of AREA Output range	0
0x1008	1	Grip error range	0 to 1000 (0.0 to 100.0%)	Minimum value of GRIP_ERR Output range	0
0x1009	1	Grip error range	0 to 1000 (0.0 to 100.0%)	Maximum value of GRIP_ERR Output range	50

*1. Apply plus or minus sign to the push-in amount. The plus sign compresses the finger to closing direction and the minus sign compresses to opening direction.

In order to execute the operation number 0, send the command to start the operation number 0 via communication or enter a signal to change the operation number to 0 by SEL0 to SEL2 Input.

7.5.5.2. Operation number 1

Address in hex	Data length	Name	Range	Description	Default
0x1100	1	Target position	0 to 1100 (0.0 to 110.0%)	Target position to stop the finger	1000
0x1101	1	Operation time	800 to 10000	Moving time to 100% position from 0% position [msec]	1000
0x1102	1	Positioning torque limit	5 to 1000 (0.5 to 100.0%)	Torque limit in motion	800
0x1103	1	Push-in amount	-1000 to 1000 (-100.0 to 100.0%)	Moving distance in Push-in operation *1 (0 = Push-in operation is invalid)	0
0x1104	1	Push-in speed	0 to 1000 (0.0 to 100.0%)	Operation speed in Push-in operation (0 = Push-in operation is invalid)	0
0x1105	1	Push-in limit torque	0 to 1000 (0.0 to 100.0%)	Torque limit in Push-in operation (0 = Push-in operation is invalid)	0
0x1106	1	AREA Output range	0 to 1000 (0.0 to 100.0%)	Minimum value of AREA Output range	0
0x1107	1	AREA Output range	0 to 1000 (0.0 to 100.0%)	Maximum value of AREA Output range	0
0x1108	1	Grip error range	0 to 1000 (0.0 to 100.0%)	Minimum value of GRIP_ERR Output range	950
0x1109	1	Grip error range	0 to 1000 (0.0 to 100.0%)	Maximum value of GRIP_ERR Output range	1000

*1. Apply plus or minus sign to the push-in amount. The plus sign compresses the finger to closing direction and the minus sign compresses to opening direction.

In order to execute the operation number 1, send the command to start the operation number 1 via communication or enter a signal to change the operation number to 1 by SEL0 to SEL2 Input.

7.5.5.3. Operation number 2

Address in hex	Data length	Name	Range	Description	Default
0x1200	1	Target position	0 to 1100 (0.0 to 110.0%)	Target position to stop the finger	0
0x1201	1	Operation time	800 to 10000	Moving time to 100% position from 0% position [msec]	1000
0x1202	1	Positioning torque limit	5 to 1000 (0.5 to 100.0%)	Torque limit in motion	800
0x1203	1	Push-in amount	-1000 to 1000 (-100.0 to 100.0%)	Moving distance in Push-in operation *1 (0 = Push-in operation is invalid)	0
0x1204	1	Push-in speed	0 to 1000 (0.0 to 100.0%)	Operation speed in Push-in operation (0 = Push-in operation is invalid)	0
0x1205	1	Push-in torque limit	0 to 1000 (0.0 to 100.0%)	Torque limit in Push-in operation (0 = Push-in operation is invalid)	0
0x1206	1	AREA Output range	0 to 1000 (0.0 to 100.0%)	Minimum value of AREA Output range	0
0x1207	1	AREA Output range	0 to 1000 (0.0 to 100.0%)	Maximum value of AREA Output range	0
0x1208	1	Grip error range	0 to 100 (0.0 to 100.0%)	Minimum value of GRIP_ERR Output range	0
0x1209	1	Grip error range	0 to 100 (0.0 to 100.0%)	Maximum value of GRIP_ERR Output range	50

*1. Apply plus or minus sign to the push-in amount. The plus sign compresses the finger to closing direction and the minus sign compresses to opening direction.

In order to execute the operation number 2, send the command to start the operation number 2 via communication or enter a signal to change the operation number to 2 by SEL0 to SEL2 Input.

7.5.5.4. Operation number 3

Address in hex	Data length	Name	Range	Description	Default
0x1300	1	Target position	0 to 1100 (0.0 to 110.0%)	Target position to stop the finger	1000
0x1301	1	Operation time	800 to 10000	Moving time to 100% position from 0% position [msec]	1000
0x1302	1	Positioning torque limit	5 to 1000 (0.5 to 100.0%)	Torque limit in motion	800
0x1303	1	Push-in amount	-1000 to 1000 (-100.0 to 100.0%)	Moving distance in Push-in operation *1 (0 = Push-in operation is invalid)	0
0x1304	1	Push-in speed	0 to 1000 (0.0 to 100.0%)	Operation speed in Push-in operation (0 = Push-in operation is invalid)	0
0x1305	1	Push-in torque limit	0 to 1000 (0.0 to 100.0%)	Torque limit in Push-in operation (0 = Push-in operation is invalid)	0
0x1306	1	AREA Output range	0 to 1000 (0.0 to 100.0%)	Minimum value of AREA Output range	0
0x1307	1	AREA Output range	0 to 1000 (0.0 to 100.0%)	Maximum value of AREA Output range	0
0x1308	1	Grip error range	0 to 1000 (0.0 to 100.0%)	Minimum value of GRIP_ERR Output range	950
0x1309	1	Grip error range	0 to 1000 (0.0 to 100.0%)	Maximum value of GRIP_ERR Output range	1000

*1. Apply plus or minus sign to the push-in amount. The plus sign compresses the finger to closing direction and the minus sign compresses to opening direction.

In order to execute the operation number 3, send the command to start the operation number 3 via communication or enter a signal to change the operation number to 3 by SEL0 to SEL2 Input.

7.5.5.5. Operation number 4

Address in hex	Data length	Name	Range	Description	Default
0x1400	1	Target position	0 to 1100 (0.0 to 110.0%)	Target position to stop the finger	1000
0x1401	1	Operation time	800 to 10000	Moving time to 100% position from 0% position [msec]	1000
0x1402	1	Positioning torque limit	5 to 1000 (0.5 to 100.0%)	Torque limit in motion	800
0x1403	1	Push-in amount	-1000 to 1000 (-100.0 to 100.0%)	Moving distance in Push-in operation *1 (0 = Push-in operation is invalid)	0
0x1404	1	Push-in speed	0 to 1000 (0.0 to 100.0%)	Operation speed in Push-in operation (0 = Push-in operation is invalid)	0
0x1405	1	Push-in torque limit	0 to 1000 (0.0 to 100.0%)	Torque limit in Push-in operation (0 = Push-in operation is invalid)	0
0x1406	1	AREA Output range	0 to 1000 (0.0 to 100.0%)	Minimum value of AREA Output range	0
0x1407	1	AREA Output range	0 to 1000 (0.0 to 100.0%)	Maximum value of AREA Output range	0
0x1408	1	Grip error range	0 to 1000 (0.0 to 100.0%)	Minimum value of GRIP_ERR Output range	950
0x1409	1	Grip error range	0 to 1000 (0.0 to 100.0%)	Maximum value of GRIP_ERR Output range	1000

*1. Apply plus or minus sign to the push-in amount. The plus sign compresses the finger to closing direction and the minus signcompresses to opening direction.

In order to execute the operation number 4, send the command to start the operation number 4 via communication or enter a signal to change the operation number to 4 by SEL0 to SEL2 Input.

7.5.5.6. Operation number 5 or later

Data name, range and default settings in the operation number 5 or later are same as the operation number 1.
Use addresses listed below.

Operation number	Address range in hex
0	0x1000 to 0x1009
1	0x1100 to 0x1109
2	0x1200 to 0x1209
3	0x1300 to 0x1309
4	0x1400 to 0x1409
5	0x1500 to 0x1509
6	0x1600 to 0x1609
7	0x1700 to 0x1709
8	0x1800 to 0x1809
9	0x1900 to 0x1909
10	0x1A00 to 0x1A09
11	0x1B00 to 0x1B09
12	0x1C00 to 0x1C09
13	0x1D00 to 0x1D09
14	0x1E00 to 0x1E09
15	0x1F00 to 0x1F09

7.6. List of communication data

7.6.1. Communication baud rate

Baud rate in hex	Baud rate in decimal	Communication speed [bps]
0x06	6	9,600
0x07	7	19,200
0x08	8	38,400
0x09	9	57,600
0x0A	10	115,200
0x0B	11	230,400

7.6.2. Input/Output contact ID

Contact ID in hex	Contact ID in decimal	I/O	Input function *1
0x0000	0	Input	SRV_ON
0x0001	1	Input	HOME
0x0002	2	Input	DRIVE
0x0003	3	Input	STOP
0x0004	4	Input	ALM_RST
0x0005	5	Input	SEL0
0x0006	6	Input	SEL1
0x0007	7	Input	SEL2
0x0008 to 0x000F	8 to 15	Input	System reserved
0x0100	256	Output	SRV
0x0101	257	Output	READY
0x0102	258	Output	ALARM
0x0103	259	Output	GRIP_ERR
0x0104	260	Output	AREA
0x0105 to 0x010F	261 to 271	Output	System reserved

7.6.3. Gripper operation ID

Operation ID in hex	Operation ID in decimal	Command description
0x00	0	No energize the gripper
0x80	128	Energize the gripper
0x90	144	Start the operation number 0
0x91	145	Start the operation number 1
0x92	146	Start the operation number 2
0x93	147	Start the operation number 3
0x94	148	Start the operation number 4
0x95	149	Start the operation number 5
0x96	150	Start the operation number 6
0x97	151	Start the operation number 7
0x98	152	Start the operation number 8
0x99	153	Start the operation number 9
0x9A	154	Start the operation number 10
0x9B	155	Start the operation number 11
0x9C	156	Start the operation number 12
0x9D	157	Start the operation number 13
0x9E	158	Start the operation number 14
0x9F	159	Start the operation number 15
0xA0	160	Stop in gradation
0xC0	192	Origin return operation

7.6.4. EEPROM access ID

Operation ID in hex	Operation ID in decimal	Command description
0x01	1	Store common parameters
0x02	2	Store parameters of the origin return operation
0x03	3	Store parameters of the function protection
0x10	16	Store parameters of the operation number 0 to 3 at one time
0x11	17	Store parameters of the operation number 4 to 7 at one time
0x12	18	Store parameters of the operation number 8 to 11 at one time
0x13	19	Store parameters of the operation number 12 to 15 at one time
0x7D	125	Delete alarm history
0x7E	126	Store all parameters at one time
0x7F	127	Restore all parameters to default

7.6.5. Alarm bit status

Alarm results once the gripper falls into abnormal status.
Remove causes of the alarm and execute the alarm reset to cancel the alarm.
The alarm information is referable with 32 bit data.
Alarm bit status is 0 when the gripper is in normal status.

Alarm bit	Alarm name	Alarm code *1
Bit 0	—	—
Bit 1	Over speed	110
Bit 2	—	—
Bit 3	—	—
Bit 4	Initial drive failure	107
Bit 5	—	—
Bit 6	—	—
Bit 7	—	—
Bit 8	Low voltage	105
Bit 9	Over voltage	104
Bit 10	—	—
Bit 11	—	—
Bit 12	Over heat	103
Bit 13	—	—
Bit 14	Over current	106
Bit 15	—	—
Bit 16	Operation prohibition after parameters change	200
Bit 17	Parameter error in origin return operation	201
Bit 18	Parameter error in individual operation	202
Bit 19	Origin return operation failure	203
Bit 20	Encoder pulse error	204
Bit 21	Operation prohibition in servo OFF	205
Bit 22	Operation prohibition due to uncompleted origin return operation	206
Bit 23	System parameter error	207
Bit 24	—	—
Bit 25	—	—
Bit 26	—	—
Bit 27	—	—
Bit 28	—	—
Bit 29	EEPROM error	—
Bit 30	CPU error	—
Bit 31	—	—

*1. The alarm code is read from the alarm history.
Refer to Section 8.2. for the details of the alarms.

7.6.6. Gripper bit status

The gripper internal information is referable with 32 bit data.

Status bit	Status name	Description
Bit 0	Energizing status of gripper	0: No energizing 1: Energizing
Bit 1	Gripper ready status	0: In busy 1: In ready
Bit 2	Alarm	0: No alarm 1: Alarm
Bit 3	GRIP_ERR output	0: Output OFF 1: Output ON
Bit 4	Reserved	–
Bit 5	Memory ready	0: EEPROM in access 1: EEPROM in ready
Bit 6	AREA Output	0: Output OFF 1: Output ON
Bit 7	Completion of origin return operation	0: Uncompleted 1: Completed
Bit 8	Finger motion	0: Free 1: Hold 2: Open/close motion 3: Origin return operation 4: Reserved 5: Reserved 6: Reserved 7: Reserved
Bit 9		
Bit 10		
Bit 11		
Bit 12 to Bit 31	Reserved	–

7.7. Appendix

7.7.1. Unit of torque, speed or position

Torque, speed and position in this product are indicated in unit of permillage 0.1% and the range is 0.0% to 100.0%.
The 1000 torque setting moves the finger set with 100.0% grip force.

The 100.0% torque corresponds to the rated current of the motor.
The torque setting is recognized with truncation in unit of 0.5%. For example, setting value 99.9% is treated as 99.5%.

The 100.0% speed corresponds to 60 degrees/sec movement speed of the robotic gripper finger.

The 0.0% position corresponds to full-open position and the 100.0% position corresponds to full-close position.
Before the origin return operation, the current position is not readable.

The acceleration in the origin return operation is set to 0.1%.
The 100% acceleration corresponds to the acceleration value at which the finger moves 60 degrees in 1 second.

- More than 100% torque may cause over heat of the motor. Note that over heat error may occur frequently.
- The resolution capacity is more than 0.1% when the finger motion range is less than 7 degrees.

7.7.2. CRC computing

In Modbus communication, data with CRC check data added to at the end is used as a check code.
CRC check is performed to the command sent from the master and the data is rejected when disaccord occurs.
Type of CRC in this product is the CRC-16.

7.7.2.1. CRC check

Exclusive disjunction, XOR, between CRC register and send/receive data is computed.
Following process is repeated in unit of a byte toward to CRC register.

1) CRC register is shifted one bit to the right, an overflowing bit is treated as a carry flag.
2) When the carry flag is ON, XOR with generator polynomial is computed.

The process above is repeated until the end data.

7.7.2.2. CRC (CRC-16) Computation

CRC procedures are following.

1) H'FFFF that is set in "CRC initial value" is loaded to CRC register.
2) XOR between CRC register and the first 1 byte data of the object data is computed, then the result is returned to CRC register.
3) CRC register is shifted 1 bit to the right.
4) When the carry flag is ON, XOR between CRC register and generator polynomial is computed then the result is returned to CRC register.
5) The process 3 and 4 are repeated until completion of 8 times of the shifting.
6) XOR between CRC register and next 1 byte data of the object data is computed, then the result is returned to CRC register.
7) The process 2 to 5 are repeated to the all data.
8) The conclusive CRC register computed by the process 7 is treated as a check code.

Generator polynomial of CRC-16
11000000000000101 (x16+x15+x2+x0)

8. Trouble shootings

8.1. Operation check LED

The gripper equips a LED indicator to show controller status.

Status	Description
No lighting	Power for the gripper is OFF
Green lighting	The gripper is in normal status such as in motion or in waiting
Red lighting	No appearance
Orange lighting	Main program is not written correctly in the flush memory
Green blinking	The gripper failed in gripping
Red blinking	The LED repeats specific blinking time in red depending on the type of the alarm
Orange blinking	The LED repeats specific blinking time in orange depending on the type of the alarm

8.1.1. Lighting or blinking in normal status

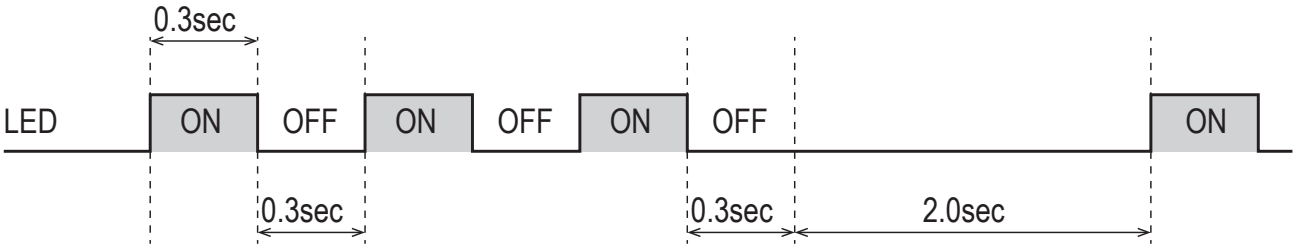
The LED lights in green in normal status.

The LED repeats the cycle that 1 sec of green lighting and 1 sec of no lighting when the controller detects gripping failure.
Refer to “GRIP_ERR Output “in Section 5.4.4. for details of the gripping failure.

8.1.2. Blinking in abnormal status

The LED blinks in red or in orange in case of abnormal status.
Count the number of lighting times to check the type of the activated alarm.
The LED repeats the blinking cycle that 0.3 sec lighting and 0.3 sec no lighting by the specific number of times. After approximately 2 sec, the LED repeats the same blinking cycles again.

Example: Blinking in red by 3 times



8.2. Abnormal detection alarm

The controller turn off energizing the gripper or stop the fingers by gradation once abnormal is detected.
Refer to the list of the alarm below for the abnormal detection.

8.2.1. List of alarm

Protection function	Number of blinking times	Causes of alarm occurrence	ON/OFF Energizing *1	Reset	Alarm code *2
Operation prohibition after parameters change	1 in orange	The origin return operation and open/close motion are prohibited after the parameters that are related to the system are changed. Execute the command to write to EEPROM then restart the gripper.	Energizing	Possible	200
Parameter error in origin return operation	2 in orange	The origin return operation is not executed when the parameters are improper Review the parameters, then again execute the command for the origin return operation	Energizing	Possible	201
Parameter error in individual operation	3 in orange	The open/close motion is not executed when the parameters are improper Review the parameters, then again execute the command for the operation	Energizing	Possible	202
Origin return operation failure	4 in orange	The origin return operation failed Remove the object from the tip of the finger	No energizing	Possible	203
Encoder pulse error	5 in orange	The finger motion range in the origin return operation is low Remove the object from the tip of the finger	No energizing	Possible	204
Operation prohibition in servo OFF	6 in orange	The fingers do not start open/close motion in non-energized status Execute the command for servo on	No energizing	Possible	205
Operation prohibition due to uncompleted origin return operation	7 in orange	The fingers do not start open/close motion in the status of uncompleted origin return operation Execute the origin return operation before the open/close motion	Energizing	Possible	206
System parameter error	8 in orange	The error occurs just after startup when the parameters related to the system are improper The settings for input signal or output signal are redundant Output signal function is applied to the contact dedicated to input signal No assignment of SEL input Reset the parameters or restart after initializing the EEPROM	No energizing	Impossible	207
Over voltage	2 in red	The input voltage level is 30V or more Check the voltage level of the input power	Selectable	Possible	104

Protection function	Number of blinking times	Causes of alarm occurrence	ON/OFF Energizing *1	Reset	Alarm code *2
Low voltage	3 in red	The input voltage level is 17V or less Check the voltage level of the input power	Selectable	Possible	105
Over heat	4 in red	The temperature of the thermistor on the controller board is 80 degree C or more Wait for a while for use until the temperature decreases.	Selectable	Possible	103
Over current	5 in red	The current level of the motor coil is more than 1.0 A Stop the use because the connection between the motor and the controller may have problems	No energizing	Possible	106
Over speed	6 in red	The motor speed is more than 500 r/min Review the operation time setting in the individual operation parameters.	No energizing	Possible	110
Initializing drive failed	8 in red	The initialing drive at the first servo on failed Remove the object from the tip of the finger	No energizing	Impossible	107
EEPROM error	9 in red	Reading from EEPROM just before startup failed This error also occurs when power is cut off during writing data Execute the command to initialize the EEPROM and set the parameters again, then reboot the gripper	No energizing	Impossible	—
CPU error	10 in red	The watchdog timer of CPU is activated by software error	No energizing	Impossible	—

*1. “Energizing” means that the controller continues to energize the gripper even in alarm status. “Selectable” allows to select whether or not to stop the energizing in alarm status.

*2. Alarm code is referable via communication. The alarm code in normal status is 0.

- More than 100% torque may cause over heat of the motor. Note that over heat error may occur frequently.

8.2.2. Alarm reset

Follow the procedure below to reset the alarm and return to normal status.

- Turn ALM_RST Input signal to OFF from ON when the signal is valid.
- Turn SRV_ON Input signal to ON from OFF when ALM_RST Input signal is invalid.
- Send the command to reset the alarm via communication.

Alarm that can not be reset reappears even the process above are executed.
Reset the alarm after removing the cause of the alarm. Otherwise the same alarm reappears.

8.2.3. Alarm history

Occurrence record is written in the EEPROM once alarm occurs. The stored record is referable vie communication.
CPU error and EEPROM error are not stored in the alarm history.
When a same alarm reoccurred, only the first record is stored and the second or later records are not stored.

8.3. Case and countermeasure

Implement proper countermeasures described in this section when the gripper operation is not in normal. Contact sales agent or our service when the measures do not work.

Case	Expected cause	Countermeasure
The gripper does not work	No power supplies to the gripper	Check the power supply is ON and the connection is correct
	Miswiring or bad conduction of the cable	Check the conduction of the cables and the wiring between the robot and the gripper
	Miswiring or bad conduction of the connection cable	Check the conduction of the cables and the wiring between the robot and the gripper
The gripper moves to opposite direction	Improper setting in the origin return direction	Check the direction setting
The moving amount does not match the setting	Improper setting in the positioning torque limit	Check the setting in the positioning torque limit
Communication error to the host	Improper setting in the termination resistor	Check the setting in the termination resistor
	Improper setting in the communication ID	Check the setting in the communication ID
The finger does not move and the startup fails (Encoder pulse error : 5 in orange)	Mistake in installing the cable holder	Remove the attachment from the gripper and make sure the cable holder is properly attached
	The gripper is tightly tightened to the closed side	Turn the hollow shaft visible on the back of the gripper, pry open the gripper, and then turn it on again

9. Option component

Contact your agent or our service for details of the followings.

- Standard attachmen
- Connection cable to the robot
- Conversion adaptor to the robot
- Customized fingers

10. Notice on product storage

- Store in a room with a temperature of -10 degree C to +50 degree C (+14 degree F to +122 degree F) and a humidity of 85% or less, no freezing or condensing.
- Do not store in a chemical atmosphere to prevent deterioration of the product.
- Do not store the product under exposed to liquids such as water or oil, dust or metal powder.
- Do not store the product under exposed to direct sunlight, heat, continuous vibration, or excessive impact.
- Do not store the product in unstable a condition to prevent drop.

11. Check

For safe use, periodical check is recommended to the items listed below after the use. Stop the use immediately and contact sales agent or our service, when any malfunction is found.

Recommended check items

- Abnormal sound from the gripper.
- Offensive odor from the gripper.
- Looseness of set screws of the gripper or the finger.
- Looseness in connector connections of the cables.
- Damage or stress to the cables.

12. Product warranty

- Within one (1) year from the date of invoice ("Warranty period"), product breakage, deformation, or defect ("Defects") by cause of Shinano Kenshi, the product or a part of the product you purchased shall be repaired, or be replaced at no charge. This warranty excludes and does not cover any defects arising from or related to the followings.
  1. Use to other than the suggested applications described in this manual.
  2. Abuse and misuse.
  3. Natural disasters, earthquake, thunder, fire, flood or so on.
  4. Negligence in observing specifications, applications, precaution of using, use conditions, drawings, and other matters that related to the product, product (including optional parts) operation manuals or against other indications regarding safe use.
  5. Unauthorized machining, repairs, modifications or disassembly.
  6. Use with another manufacture's devices.
  7. Exceeding product life.
  8. Other than above, defects cannot be attributed to Shinano Kenshi.
- After warranty period or out of the warranty, any and all repairs, replacements and consumable replacements will be charged appropriately.
- Shinano Kenshi is not liable for direct damages, loss of opportunities, special damages, incidental damages and other consequent damages or loss caused by production line stop of factory and factory facilities with using our products.

13. Notes

- Reprinting or copying this manual is prohibited.
- Product name, specifications and/or dimensions are subject to change without prior notice for product improvement.
- Products shown in this manual may be discontinued without prior notice.

Contact information

Contact sales agent or our service below for technical questions or consultations.

Prepare following information before the contact.

- Name of the product.
- Date, month and year of your purchase.
- Detailed contents of the consultation.

Contact

Plexmotion Support Center
E-mail: Plexmotion@skcj.co.jp

Manufacturer

Shinano Kenshi Co.,Ltd.
Head office: Zip code 386-0498, 1078 Kami-maruko, Ueda, Nagano, Japan
URL: jp.aspina-group.com

REVISION 000 / Mar-2021